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ABSTRACT

The proper use of agricultural pesticides is the major emphasis on the unit of instruction developed as a guide for use by teachers in planning and conducting young farmer and adult farmer classes. Seven lessons are included in the unit covering topical areas related to the utilization of pesticides, herbicides, insecticides, fungicides, and the development of a comprehensive pest control program. Suggestions for teaching the lessons and suggested materials are presented. Teaching forms and a unit evaluation questionnaire are presented. (VA)

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AGRICULTURAL PESTICIDES

An Instructional Unit for Teachers
of Adult Vocational Education in Agriculture

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FOREWORD

Mr. Kenneth Harrison, teacher of vocational agriculture at Ohio County High School, brings to this publication 16 years of teaching experience, including 14 years of teaching adult farmers in Warren and Ohio counties. He has also been employed in the chemical industry, serving as Field Representative for the Niagara Chemical Company from 1961 to 1965. Since returning to teaching he has established an 18 acre peach orchard where many ideas expressed in the publication have been applied. Mr. Harrison holds the B.S. and M.S. degrees from the University of Kentucky. He has served as KVATA District President and is active in numerous other civic and professional activities.

This adult-farmer course is a result of the following sequence of actions:

1) The State Advisory Committee made up of agriculture teachers, State staff, and teacher educators from throughout Kentucky, was organized to determine needs and program direction for adult work in agriculture for the State. A major outcome of the first meeting in September, 1971, was a recommendation that more instructional materials specifically designed for teaching adults in agriculture be developed and distributed to teachers.

2) Subsequently, a proposal to involve experienced teachers of adults in material development was written by Dr. Maynard Iverson of the University of Kentucky and submitted for State funding. In January, 1972, a two-year grant was made through the Supporting Services Division, Bureau of Vocational Education, State Department of Education.

3) Twelve teachers were selected to produce units in the diverse areas of need during the course of the project.

This publication, along with other materials developed specifically for instruction of adults employed in agriculture in Kentucky, should improve the teaching of adult classes in agriculture and stimulate the initiation of additional classes.

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We are grateful to the following for their valuable assistance with the unit: Professor Don Hamilton, Vincennes (Indiana) University; Dr. James Worthington, Agriculture Department, Western Kentucky University; Mr. John Kavanaugh, Ohio County Agent; Mr. Arrel Himes, Ohio County Health Sanitation Office; Dr. Clifford Martin, North Carolina State University; Mr. Harold Geuther, Sales Representative, Niagara Chemicals Co., Jacksonville, Illinois; Dr. Rodney Tulloch, University of Kentucky; Mr. Kenny Maddox, Junior Chamber of Commerce, Beaver Dam; J. Edsel Moore, Director, Pesticide Program, Division of Environmental Service, State Department of Health; (all of whom assisted in securing initial references); Dr. Doug Gaydon, Pesticide Coordinator, Division of Regulatory Services, and Dr. Frank Pattie, Professor Emeritus, both of the University of Kentucky, for critically reviewing the manuscript; Mr. Raymond Gilmore and Mrs. Donna Phipps Stout, artists in the Curriculum Development Center, University of Kentucky; Mrs. Anne Mills, secretary, and Ms. Linda Ledford, Ms. Carol Ledford, Ms. Corinne Keenon, typists, University of Kentucky; Dr. Robert Schneider, Director, Education Resources Development Unit, Bureau of Vocational Education, for expediting financing of the project, and especially to the many authors and agencies whose publications were utilized in the unit.

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SUGGESTIONS FOR USING THE COURSE

This unit was developed as a guide for use by teachers in planning and conducting young farmer / adult farmer classes. Because of the diversity in age, expertise and experience levels of class members and instructors, the unit was designed to cover the basic areas of agricultural pesticides. Therefore, teachers should adapt those portions of the unit that are suited to their particular situation. Seven lessons have been included, but the unit may be expanded to more topics or utilized in diversified courses for shorter periods of instruction. It may be helpful to involve class members at the organizational meeting in the selection of lessons and activities. Planning forms to assist in this process are found in the Appendix. We highly recommend that teachers planning to utilize this unit secure a variety of references, many of which are available from the Agricultural Extension Service.

The format used was designed to assist teachers in utilizing problem-solving and the discussion method. A teaching procedure that has been used successfully is as follows: Step 1: The teacher lists the topic (problem and analysis) on the chalkboard. Step 2: He then sets the stage for discussion with introductory facts, ideas, or comments, using items from the section on "developing the situation." Step 3: The teacher calls on the class to give their experiences, ideas, and knowledge concerning the subject. The discussion is supplemented with handouts, transparencies, models, or other inputs gathered by the teacher beforehand to help solve the problem under consideration. Resource people or films may also be used here as sources of information. (Transparency and handout masters are found at the end of each lesson in the unit.) Step 4: When the facts have been brought out and a good discussion has taken place, the teacher leads the group to appropriate conclusions. These summary statements are written on the chalkboard and in some cases are typed up and distributed as handouts at the next meeting. Some instructors will utilize devices such as panels, exhibits, and tours to reinforce the conclusions reached. Several suggestions for supplementary enrichment activities are listed in each lesson of the unit.

Teachers may want to utilize the wealth of resources found in each community to supplement their teaching -- local applicators, chemical company representatives, and others will undoubtedly be pleased to serve as resource people, furnish

samples, give demonstrations, conduct tours, arrange for films and assist with other activities appropriate to the success of the course.

Each teacher using the unit is asked to complete and return the evaluation questionnaire found in the Appendix. These ratings and suggestions will be used to improve this unit as well as others developed in the series.

Our best wishes for a successful adult program.

Kenneth M. Harrison
Development Consultant

Maynard J. Iverson
Project Director

UNIT OBJECTIVES

Major Objective: To develop the effective ability of farmers to use agricultural pesticides properly.

Lesson Objectives: To develop the effective ability of farmers to:

1. Understand the importance of Agricultural pesticides.
2. Use and handle agricultural pesticides safely.
3. Develop a comprehensive pest-control program.
4. Properly utilize herbicides in controlling weeds in the commonly grown crops.
5. Utilize insecticides in the commonly grown crops.
6. Properly use fungicides in plant-disease control.
7. Utilize miscellaneous pesticides.

UNIT REFERENCES

Books

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Book II Herbicides
Book III Fumegants, Growth Regulators, Repellents, and Rodenticides.

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"Pesticides in the Environment," (xerox) (U.S. Government Printing Office, Washington, D.C.) undated.

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"The Ecology of Pesticides," (xerox) Training Handbook by Eldon P. Savage, (ULS. Dept. of Health, Education, and Welfare, Public Health Service, Consumer Protection and Environmental Health Service, Food and Drug Administration, Office of Product Safety, Division of Communities Studies) undated.

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"Pests or Plenty," color, released 1965, 13 minutes, (an introductory film).

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"Rinse and Drain," Slide set, 24 slide set, casette, approx. 12 min., (National Agricultural Chemical Association).

"Survival in a Competitive Environment," (Department of Public Information, Agriculture Experimental Station, Lexington, Kentucky), 71 slide set, casette, 30 min., 1973.

"The Safe Use of Pesticides," color, released 1963, 21 1/4 minutes.

"The Wicked World of Weeds" (Weed Science Society of America,) 75 slide set, Documentary.

Lesson 1

IMPORTANCE OF AGRICULTURAL PESTICIDE USAGE

Objective -- To develop the effective ability of farmers to understand the importance of agricultural pesticides.

Problem and Analysis -- How important are agricultural pesticides to modern farming?

-Economic importance to producers
-Economic importance to consumers
-Trends in pesticide usage
-Classification of Agricultural Pesticides
-Pesticide terminology

Content

I. Economic Importance to Producers

A. Annual loss to crops in the United States from plant insects and diseases is estimated at three billion dollars, much of which can be controlled by proper use of appropriate pesticides. Failure to maintain adequate control results in the following:
   1. Decreased yield (Refer to masters at the end of lesson.)
   2. Lower quality of produce (See Geigy slides.)
   3. Reduction in growth and vigor of plants
   4. Death of plants

B. Nationwide, annual loss due to lack of weed control runs into five billion dollars.
   1. It is estimated that an average of $7 per

acre of corn is lost due to weeds. Severe losses reach to $30 to $40 per acre.

2. Use of herbicides to control weeds results in increased yields and a lowered cultivation cost.
3. Around-the-farm weed control means greater efficiency and safer and more pleasant working conditions.
4. Use herbicides for weed control whenever weeds are unsightly, a severe source of weed seed, or when they create hazardous conditions as follows:
   --Along fence rows
   --In barnyards and around farm buildings
   --In roadways and driveways
   --In storage areas for oil or gasoline
   --In storage areas for machinery, equipment, supplies, grain, and in field lots.

C. Economic losses from death of farm animals (or reduced production) due to parasites and diseases are estimated at a billion dollars annually.
   1. External parasites amount to approximately 400 million dollars loss in cows and calves.
   2. Cattle grubs, screw worms, flies, and ticks cost approximately 235 million dollars annually.
   3. Internal parasites in cattle cost producers approximately 40 million dollars each year.

II. Economic Importance to Consumers

A. Few countries today excel the United States in food quality and quantity available to the consumer.

B. Due to increased technology (including pest control), each farmer improved his capability of producing enough for himself and 46 others today, as compared to enough for one other, himself, and his family in the early 1900's.

C. In the United States, the consumer spends 16 percent of his family's disposable income for food, in Russia 50 percent, and in India 70 percent.

III. Trends in Pesticide Usage

A. More than $210 million were spent on pesticides (insecticides, fungicides, nematocides, and herbicides) in the United States during the 1971 growing season. About 8% was spent for fungicides, representing a considerable outlay for the control of plant diseases.

B. The sharply rising production of agricultural pesticides is one measure of their value in agriculture for controlling disease-bearing pests and for other uses. United States production of pesticidal chemicals was more than one billion pounds in 1967; 18 percent higher than 1965. Production for the year 1967 includes material for export.

IV. Classification of Agricultural Pesticides

A. There are a number of general classifications of pesticides that need to be defined. (See Pesticide Terminology for definitions.) When agricultural pesticides are mentioned, often the first thing that comes to mind is weed spray. While the weed killers are the largest group of pesticides, there are others which need to be considered. The two major groups are insecticides and herbicides.

B. Other pesticides will fall into the following categories:
1. Fungicides, defoliants, plant regulators
2. Attractants, repellents, fumigants, and rodenticides

V. Pesticide Terminology

(To establish an understanding of terms that apply to pesticide usage, refer to masters of terms included at the end of lesson.)

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. Pesticides are playing an increasing role in the production of agricultural products, both crop and livestock.
2. A comparison of two inputs of production--fertilizers and pesticides--shows that returns per dollar spent are $4.50 and $4.16, respectively.
3. Of the consumer dollar the consumer spends about 16 percent for food.
4. Regulations and restrictions on continued use of pesticides are going to increase, and regulations are enforced by the environmental protection agency (EPA).

B. Things to be brought out by class members:
1. Their experiences with pesticides (successful and unsuccessful results)
2. Trends in personal usage of pesticides
3. Opinions on what it would be like to farm without the use of pesticides

II. Conclusions

A. Pesticides are one of the accepted tools of production and rank next to fertilizer in dollars returned per dollar spent.

B. Agricultural pesticide usage is increasing each year.

C. Regulations and restrictions on pesticidal use are going to increase. Therefore, an increase in knowledge and responsibility will be required on the part of each user.

III. Enrichment Activities

A. Use chalkboard with suggested form to draw on student experiences with pesticides.

B. Display samples of packaged pesticides, such as insecticides, herbicides, fungicide, and any other available from a local dealer.

IV. Suggested Teaching Materials

A. References for Lesson 1

1. Agricultural Chemicals (Student Manual), pp. 3-4.
2. Pesticides in the Environment, pp. 195-196.
3. The Ecology of Pesticides.
4. Twenty-fifth Illinois Spray Guide, pp. 181, 313-318.
5. Weed Control - Cultural and Chemical, pp. 1-4.

B. Resource personnel
   1. Cooperative Extension Specialist
   2. Consult local sources
   3. For specific personnel, see VoAg Directory of Resource People in Kentucky.

C. Audio-visuals
   1. Masters*
      -1A-N Common Terms
      -2 Inventory of Pesticide Use (Table)
      -3 How Much Can Foxtail Reduce Soybean Yields? (Chart)
      -4 How Much Can Foxtail Reduce Corn Yields? (Chart)
      -5 U. S. Production of Pesticide Chemicals (Chart)

*Masters are keyed to units and lessons, and are numbered consecutively. The code number appears in the lower right hand corner. Master 109-1-1A indicates: adult unit 109, lesson 1, item 1, part A.

COMMON TERMS FOR CUSTOM APPLICATION OF PESTICIDES

ABSORPTION

The entrance of a chemical into a plant or microorganism.

ACARICIDE

A chemical used to kill mites (an insect relative). Also known as miticide.

ACTIVE INGREDIENTS

The actual amount of pesticide present in the formulation.

ADSORPTION

The binding of a chemical to the outside surface of small soil particles (soil colloids) or to plant parts.

AEROSOL

Suspension of a liquid or solid in air.

AGITATE

To keep a mixture stirred up.

ANNUAL WEEDS

Weeds that live one year and are propagated only by seed.

ANTIDOTE

A remedy used to counteract the effects of a poison.

APPLICATION RATE

Similar to dosage but more inclusive. For example: apply Malathion at 1 pound actual chemical per acre in 10 gallons of water.

AVICIDE

A substance to control pest birds. Generally not designed to kill, but to repel or to so affect a few individuals that others are frightened away.

ATTRACTANT

A substance used to attract destructive animals. Usually used with a killing agent.

AVOID

Don't do it. For example "avoid spraying on windy days" means don't spray on windy days.

AVOID PROLONGED CONTACT

Do not allow spray to remain in contact with the skin, or do not breathe spray or fumes over a long period of time. Usually means hours.

BAND APPLICATION

Application as a band usually made over or beside a crop row.

BASAL APPLICATION

Application as a band directed at the base of a plant.

BIENNIAL WEEDS

Weeds that live for more than one year but not more than two years.

BIOLOGICAL CONTROL

Control of pests by means of living organisms, e.g., predators, parasites, and disease-producing organisms.

BLANKET APPLICATION

Application of a chemical over the entire area.

BROADCAST APPLICATION

Application made uniformly over an entire field.

CARCINOGEN

A substance that will produce cancer.

CARRIER

Inert material, such as dust, clays, oils, water, and air, that is mixed with the pesticide and provides for more uniform dispersal of the pesticide.

CHEMOSTERILANT

A chemical used to sterilize insects.

CHLORINATED HYDROCARBON INSECTICIDE

Synthetic compounds that contain hydrogen, carbon, and chlorine. They are persistent insecticides that kill insects mainly by contact action. They are insoluble in water and are decomposed by alkaline materials and high temperatures. Examples: DDT, aldrin, dieldrin, heptachlor, lindane, toxaphene, methoxychlor.

CHLOROSIS

When leaves turn yellow and lose their green color, either partially or completely.

COMBUSTIBLE

Will burn if near an open flame.

COMPATIBLE CHEMICALS

Chemicals that can be mixed together and still maintain a satisfactory physical state without decreasing their effectiveness against the intended pests.

CONCENTRATION

The amount of actual pesticide or active ingredient contained in a formulation or mixture to be applied.

CONTACT HERBICIDES

Herbicides that kill on contact. Example: paraquat.

CONTAMINATED

Too much spray on the food, possibly as a result of spillage. The food should not be eaten or sold. Clothing that has gotten a lot of pesticide on it is also contaminated, and warnings against wearing contaminated clothing should be followed.

CROP TOLERANCE

The ability of a crop to be treated with a chemical without injury.

DEFOLIANT

A chemical which causes the leaves to drop from the plant.

DESICCANT

Material that cuts through or penetrates the skin of insects or the leaf surface of plants and causes their tissues to dry out.

DILUENT

Any material used to dilute a pesticide to the desired concentration.

DIRECTED APPLICATION

Implies application to a specific kind of plant or parts of a plant.

DORMANT PERIOD

Period of time in which seeds and other plant parts are not growing due to natural causes. (Example: apple trees in the winter.)

DOSAGE

The amount of pesticide to be applied on a given area (e.g., an acre) or per unit of water.

DRIFT

Movement of material outside the intended target area during or shortly after application.

EDIBLE PARTS

Parts of a plant that are used for human or animal food.

EMETIC

Something that causes vomiting to get rid of poison in the stomach; an antidote.

EMULSIFIABLE CONCENTRATE

A liquid formulation containing a high amount of pesticide dissolved in a solvent together with an emulsifier. Designed to be mixed with water to the desired strength before being used.

EMULSIFIER

A chemical which helps keep one liquid mixed with another; one which mixes oil in water.

EMULSION

A mixture in which a pesticide in a liquid form (as minute globules) is suspended in water.

FORMULATION

The form in which the pesticide is offered for sale to the user, as emulsifiable concentrate, wettable powder, granules, dust, oil solution, etc.

FC (FULL COVERAGE)

The total amount of pesticide spray applied which will thoroughly cover the crop being treated to the point of runoff or drop.

FUMIGANT

A chemical which as a gas kills destructive animals and plants.

FUNGICIDE

A chemical used to kill fungi.

FUNGISTATS

A chemical which inhibits the growth of fungi.

GRANULES

A formulation in which the pesticide is attached to particles of some inert carrier like clay or ground corn cobs. Size of most presently used granules is 15 to 40 mesh.

GROWTH REGULATOR

A hormonal chemical capable of changing the growth characteristics of a plant.

HAZARD

The relative likelihood of ill effects or other danger.

HERBICIDE

A chemical used to kill or inhibit plant growth.

INCORPORATE INTO SOIL

To mix a herbicide or insecticide in the soil by mechanical means.

INFESTATION

An attack by insects; areas where insects are seen on the plant.

INHIBIT

To hamper or prevent seed from germinating or to stop plant growth.

INSECTICIDE

A chemical used to kill insects.

LABEL

A printed statement affixed to the pesticide container by the manufacturer listing the contents, directions for use, and precautions. A pesticide label must be approved and registered by the Federal EPA and the Division of Regulatory Services, College of Agriculture, U. of Ky.

LARVA

The immature or worm stage (caterpillar, maggot, grub) of an insect which passes through 4 stages (egg, larva, pupa, adult) in its development.

LARVACIDE

An insecticide used to kill larvae of insects.

LC50 (Lethal Concentration--50)

Amount of pesticide in water or air required to kill 50% of a test animal population in a 24-hour period. Usually used for fish.

LD50

Amount of pesticide taken orally or dermally required to kill 50% of a test animal population. Lethal dose 50. Usually expressed in terms of milligrams of pesticide per kilogram of body weight of the test animal.

LV (LOW VOLUME)

Means that the total volume of pesticide spray applied is adequate to uniformly cover the crop but not as a full-cover spray to runoff.

LVC (LOW VOLUME CONCENTRATE)

Refers to the pesticide formulation designed for "Ultra Low Volume" (ULV) applications. Usually a highly concentrated liquid formulation of a pesticide applied undiluted or with only a small amount of diluent added (usually an oil).

50-MESH SCREEN

Screens or strainers which have 50 holes per linear inch.

Mg/kg

Used to express the amount of pesticide in milligrams per kilogram of animal body weight to produce a desired effect. 1,000,000 milligrams = 1 kilogram = 2.2 pounds.

MISCIBLE

A substance that will mix with other substances (generally refers to liquids).

NEMATOCIDE

A chemical that kills nematodes.

NEMATODE

Generally microscopic, unsegmented roundworms, usually living free in moist soil, water, or decaying matter or as parasites of plants and animals.

NOZZLE

A device for metering a spray solution.

NYMPH

The immature stage (resembling an adult) of an insect which passes through three stages (egg, nymph, adult) in its development.

ORGANIC PHOSPHORUS INSECTICIDE

A synthetic compound derived from phosphoric acid. Organic phosphorus insecticides are primarily contact killers with relatively short-lasting effects. They are decomposed by water and high temperature. Examples: malathion, parathion, diazinon, phorate, TEPP, dimethoate, etc.

ORIFICE

An opening in a nozzle tip, duster, or granular applicator through which the spray, dust, or granules flow.

OVICIDE

An insecticide used to kill the eggs of insects.

PARASITIC INSECT

An insect which lives in or on the body of another organism at the expense of the host.

PATHOGEN

An organism or agent capable of causing disease.

PERENNIAL WEED

A weed that lives for more than two years.

PESTICIDE

A chemical or mixture of chemicals used to kill any animal or plant considered as a pest.

PHYTOTOXIC

A chemical that is injurious or poisonous to plants.

POISON

A chemical causing a deleterious effect when absorbed or eaten by a living organism (biocide).

POSTEMERGENCE

Implies application of a chemical after emergence of the crop or weed.

PPB

Two crystals of sugar in 1,000 pounds, 1 ounce in 8,000,000 gallons, 1 inch in 16,000 miles. (PPB = parts per billion)

PPM

Two crystals of sugar per pound, 1 ounce in 8,000 gallons, 1 inch in 16 miles. (PPM = parts per million)

PREDATORY OR PREDACEOUS INSECTS

Insects which feed on other insects.

PREEMERGENCE

Implies an application of a chemical before emergence of the crop.

PREPLANT TREATMENT

Treatment before planting.

PROPER DOSAGE

The right amount, according to label directions.

PROTECTANT

A chemical used to prevent infection or infestation by an organism.

PUPA

The resting stage of an insect which passes through four stages (egg, larva, pupa, adult) in its development.

REPELLENT

A chemical used to repel rather than kill an animal pest.

RESIDUAL

A characteristic of a pesticide to persist after application in amounts sufficient to kill pests, usually for several days to several weeks or even longer.

RESISTANT SPECIES

Pests that survive relatively high rates of application.

RESIDUE

Amount of pesticide present after application.

RODENTICIDE

Rodent killer (rats, mice, etc.)

RUNOFF

Pesticide material that is carried away from an area by flow of surface water. Also used to describe the rate of application to a surface, i.e., "spray to runoff."

SAFETY

The practical certainty that injury will not result from the proper use of a pesticide.

SELECTIVITY

Ability of a chemical to kill some pests but not affect others.

SELECTIVE HERBICIDES

Herbicides that are effective in controlling certain plant species without affecting others.

SOIL STERILANTS

Completely prevent growth of higher plant life.

SOIL STERILIZATION

Treating soil by heat or chemicals to kill living organisms.

SOLUBILITY

The maximum amount of a liquid or solid that will dissolve in a unit amount of liquid.

SOLUBLE POWDER

A powder formulation that dissolves and forms a solution in water.

SOLUTION

A mixture in which the pesticide is dissolved, in a liquid, usually in an oil solvent. The pesticide, as individual molecules, is evenly dispersed among the molecules of liquid.

SPOT TREATMENT

Application to a restricted or small area.

SURFACTANT

A material which reduces surface tension between two unlike materials such as oil and water. A spreader or wetting agent used to increase coverage of the surface being sprayed.

SUSPENSION

A mixture in which the pesticide in a solid form (tiny particles) is suspended in water.

SUSCEPTIBLE SPECIES

Pests readily killed by relatively low rates of chemical application.

SYMPTOMS

Responses of a plant or animal to the pest's activities.

SYNERGIST

A chemical that when mixed with a pesticide increases its toxicity. The synergist may or may not have pesticidal properties of its own.

SYSTEMIC PESTICIDE

One absorbed by treated plants or animals and translocated via their circulatory system to other tissues.

TENACITY

Tendency of a pesticide deposit to resist removal by weathering.

TOLERANCE

The amount of pesticide deemed safe and permitted by law on an agricultural product.

TOPICAL APPLICATION

Implies application to the top or to the upper surface of the plant; thus applied from above.

TOXIC

Poison that can kill or harm insects, animals, or humans.

TOXIC SYMPTOMS

Signs that tell if a person has been poisoned.

TOXICITY

Capacity of a pesticide to do harm.

TOXIN

A poison produced by a plant or animal.

TRANSLOCATED

An insecticide or herbicide which moves within the plant or animal. Example: from roots to leaves.

ULV (ULTRA LOW VOLUME)

Spraying by air or ground, an insecticide undiluted and in a very concentrated liquid form. Dose usually from 2 to 16 fluid ounces per acre, but always less than one-half gallon per acre.

VOLATILITY

The rate of evaporation of a chemical.

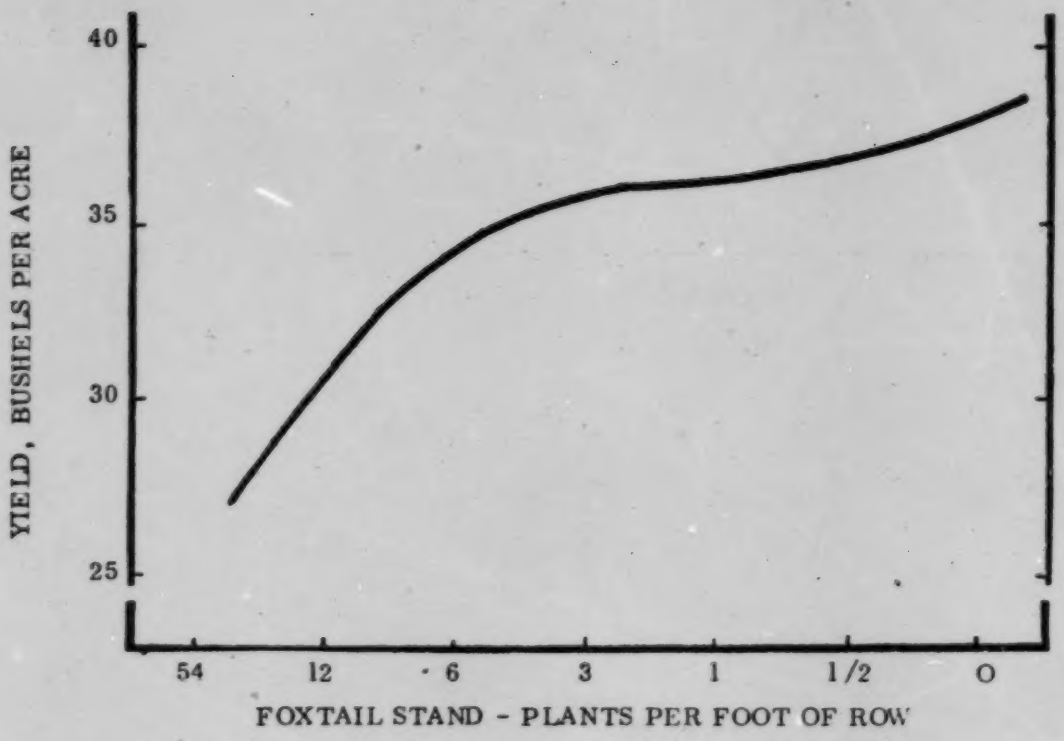
WETTABLE POWDER

A powder formulation containing a wetting agent that causes the powder to form a suspension in water.

INVENTORY OF PESTICIDE USE NAME

WHERE HAVE YOU USED THESE PESTICIDES?	POSSIBLE AREAS									
	TOBACCO	CORN	SOYBEANS	HAY CROPS	VEGETABLES	BEEF	DAIRY	HOGS	OTHER LIVESTOCK	BLDGS.
INSECTICIDES										
FUNGICIDES										
HERBICIDES										
RODENTICIDES										
ACARICIDES (Miticide)										
AVICIDES										

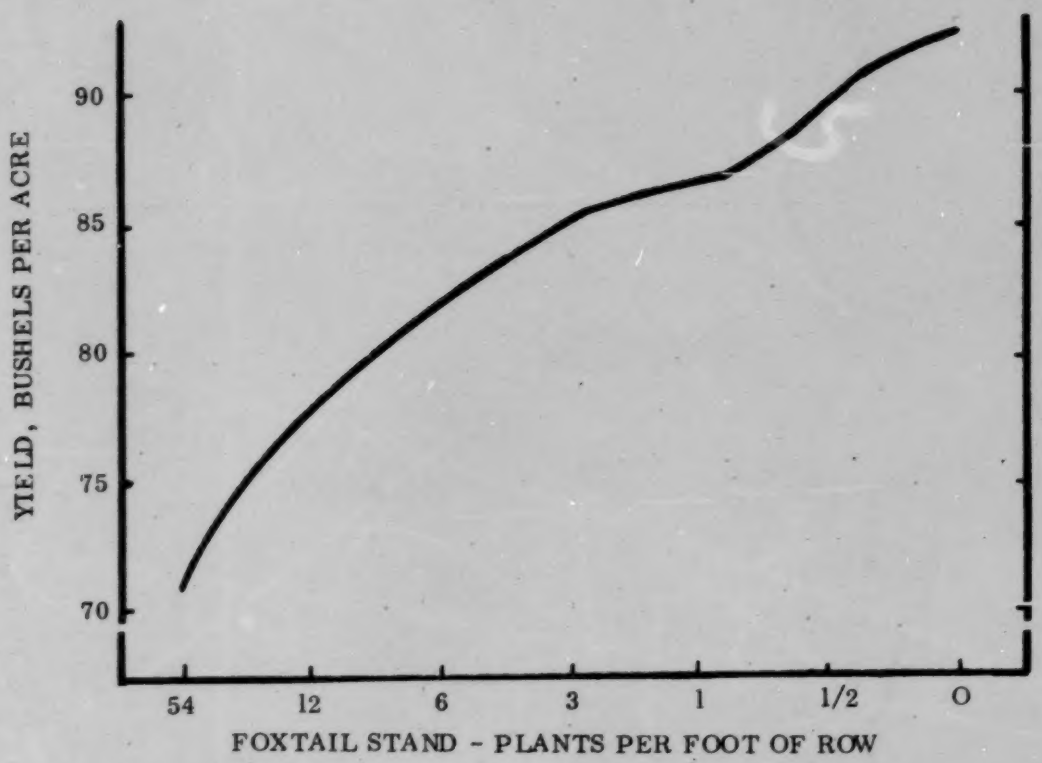
HOW MUCH CAN FOXTAIL REDUCE SOYBEAN YIELDS?



SOURCE: University of Illinois

109-1-3

HOW MUCH CAN FOXTAIL REDUCE CORN YIELDS?



SOURCE: University of Illinois.

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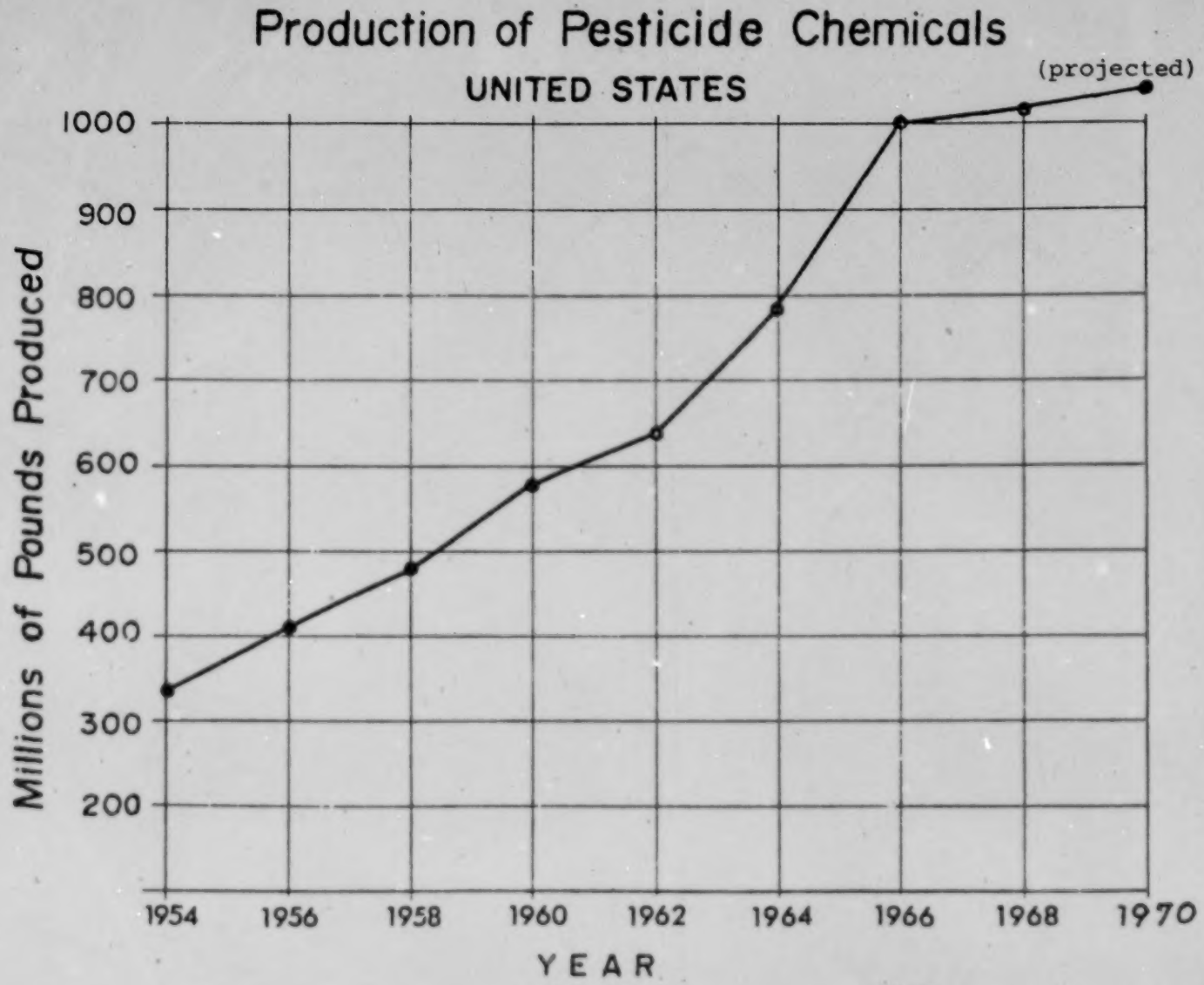


SOURCE: THE ECOLOGY OF PESTICIDES

109-1-5

Lesson 2

USING AND HANDLING AGRICULTURAL PESTICIDES SAFELY

Objective -- To develop the effective ability of applicators to use and handle agricultural pesticides safely.

Problem and Analysis -- How can we use and handle pesticides safely?

-Individual responsibilities
-Safe pesticide usage
-Safe storage of pesticides
-Pesticide disposal

Content

I. Individual Responsibilities (Legal and Moral).

A. Effective January 1, 1978, the Kentucky Pesticide Use and Application Act became law. In this Act, the legal requirements are set forth regarding the farmer, "Pesticide Applicator," "Pest Control Consultant," and "Public Operator," (KRS, Ch. 217, Sec. 18).

B. The purpose of this Act is to regulate, in the public interest, the use and application of insecticides, fungicides, herbicides, defoliants, nematocides, rodenticides, and any other pesticides designated by the Director of Regulatory Services.

C. For assurance of continued pesticidal use, we must individually assume greater responsibility. Since it will be demanded, now is the time to nail down important facts on pesticide safety and use.

II. Safe Pesticide Usage

A. To fully understand the meaning of safe pesticide

usage, we must explore the necessity for safe application. This has to be dealt with in terms of definitions and examples. Pesticides are toxic. Toxicity means the inherent capacity of a substance to produce injury or death in animals or humans. The toxicity of a pesticide is determined by the lethal dose (L.D.). LD/50 means the dosage or concentration of a chemical that will kill approximately 50% of the test animals in a certain length of time. The LD/50 varies depending upon the routes of absorption (oral or dermal) and the percentage of active ingredient. Example: A material with only 50% active ingredient requires twice as much to produce a toxic effect as 100% pure material. Pesticides vary in the degree of toxicity class or rating. The lower the LD/50 value the greater the toxicity. The ranges and LD/50 oral rating, from highest to lowest, are:

1. Extremely toxic -- less than 1
2. Highly toxic -- 1-50
3. Moderately toxic -- 50-500
4. Slightly toxic -- 500-5000
5. Practically non-toxic -- 5000-15000
6. Relatively harmless -- 15,000+

To translate the amount of LD/50 into the number of ounces that would be fatal to 50% of a group of men whose weight averaged 180 lbs., multiply Mg/Kg by 0.003 to get ounces per 180 lb. man. Example -- a chemical with a toxicity rating of 50 would require 50 x .003 = .15 oz.

B. Information about chemical toxicity to humans has been obtained from accidental exposures to harmful levels of chemicals, from suicides, and indirectly from tests on mice, rats, guinea pigs, poultry, dogs, and monkeys.

C. Safe transport of pesticides (from dealer to farm)
   1. Due to certain restrictions, it has long been a practice that pesticide distributors, dealers, and retailers be cautious in the warehousing of pesticides where food and feedstuffs may be contaminated.

2. Purchasers of pesticides should not:
   a. Load pesticides with groceries and feed
   b. Carry pesticides inside car or truck cab due to possible spills or fumes from material volatization

D. Reading the label
   1. The label of a pesticide and the adherence to it are nearly priceless to the user in terms of proper use and safety.
   2. Cost of pesticide development
      a. Before it can be sold, some 30 research steps, 100,000 man hours of testing, 8 to 10 years, and $6 to $10 million are needed to bring just one pesticide to market for man's use.
      b. In addition, the pesticide label has to be approved and registered by the Pesticide Regulations Division of the Federal EPA.
   3. One of the following hazard warnings will appear on a pesticide label:
      a. The word caution means the material is of low toxicity and hazard.
      b. The word warning means the material is of moderate toxicity and hazard.
      c. The word poison on a pesticide label (printed in red and displaying a skull and crossbones) means the material is of high toxicity and hazard.
      d. These words -- caution, warning, and poison -- dictate the type of protective clothing and/or devices one must use.

E. Symptoms of pesticide poisoning
   1. Symptoms of pesticide poisoning may resemble fatigue or other common conditions of illness. Specific signs of poisoning vary, depending on the pesticide involved. Generally, these include headache, blurred vision, nausea, cramps, diarrhea, and chest discomfort.
   2. Highly toxic pesticides have the antidote listed on the label. In case of poisoning, your doctor must know the antidote or active ingredient of the chemical in order to ad-

minister treatment.
3. Have on record the nearest poison-control center phone number.

F. Personal protective equipment
1. (See words caution, warning, and poison under the section on Reading the Label.)
2. On pesticides identified as poison, all precautions on the label must be strictly followed. Since these pesticides are extremely poisonous, wear protective clothing and devices at all times during mixing and application.
3. Shower or bathe as soon as the job is finished and put on clean clothes.
4. Do not smoke or eat while handling pesticides.

G. Safe mixing procedures
1. The greatest danger to the user is during preparation of pesticides for application. Care must be taken to prevent breathing the pesticide, getting it on your skin, or in your eyes.
2. In mixing highly toxic pesticides, have someone keep an eye on you for signs of toxic effect.
3. In mixing combinations of pesticides, be sure to check a spray-compatability chart.

H. Application procedures
1. You are the only one who can keep yourself safe when you are applying pesticides. Work safely. Know the danger of the pesticide you are using and how to keep yourself from being poisoned.
2. Temperatures during application can be a critical factor affecting results. Do not apply any fungicide or pesticide when temperature is above 85°F.

I. Re-entry precautions
1. Regulations and restrictions on re-entry of fields following a pesticide application are becoming more strict.
2. New regulations appear to be forthcoming. Watch for them.

III. Safe Storage of Pesticides

A. Improper storage increases the possibility of injury to children and livestock; keep storage locked.

B. Store pesticides in original containers; unmarked or improperly identified pesticides will undoubtedly be used for the wrong purpose.

C. Store pesticides only in an area set aside for this purpose. Do not store with food or feed.

IV. Pesticide Disposal (involving empty containers, spills, and in case of fires)

A. Check the product label of the manufacture for procedures for safe disposal of empty containers.

B. In cleaning up spills, use protective equipment and devices as you would in mixing and applying.

C. To clean up spills:
1. Use an absorbent cleaning compound such as clay, sawdust, or soda ash.
2. Sweep and shovel contaminated material into a fiber container and dispose of this by burning or burying in the soil at least 18 inches deep. Select a site for burying so as to avoid contaminating underground water supplies.
3. Further decontaminate the area of any spill by flushing with water or using a full strength chlorine bleach.

D. Pesticide fires are very dangerous and hazardous and require the assistance of trained firemen. A list of stored pesticides should be filed with the local fire department.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. Introductory statement -- As you may know by now, the federal government has banned uses of DDT in this country. It is being replaced by pesticides that have less long-term residual effect on the environment. Going to pesticides with a shorter-term residual, in many instances, requires the use of a more highly toxic pesticide, but this can be done safely by:
   a. Realizing the importance of following <u>all</u> the safety practices in using the more toxic pesticides
   b. Being well enough informed to assure safety to those people we may employ
   c. Realizing pesticide safety has become one of our added responsibilities
2. Meaning of safety terms
3. Calculation of lethal dosage

B. Things to be brought out by class members:
   1. Any information about chemical toxicity injury or death due to improper knowledge of safety
   2. Any crops or livestock that failed to get marketed due to improper use of pesticides

II. Conclusions

A. Proper and safe use of pesticides has been and will continue to be a major responsibility.

B. A greater awareness of safety is needed due to more individuals using and handling more toxic pesticides than in the past.

C. Store pesticides properly; store under lock and key, out of reach of children, pets, and livestock, and away from food and feed.

D. Disposal of empty pesticide containers, and taking care of spills are also very important and essential to safe use of pesticides.

III. Enrichment Activities

A. Have a fire department speaker or demonstration on control of chemical fires.

B. Provide each class member with a list of the poison control centers in Kentucky.

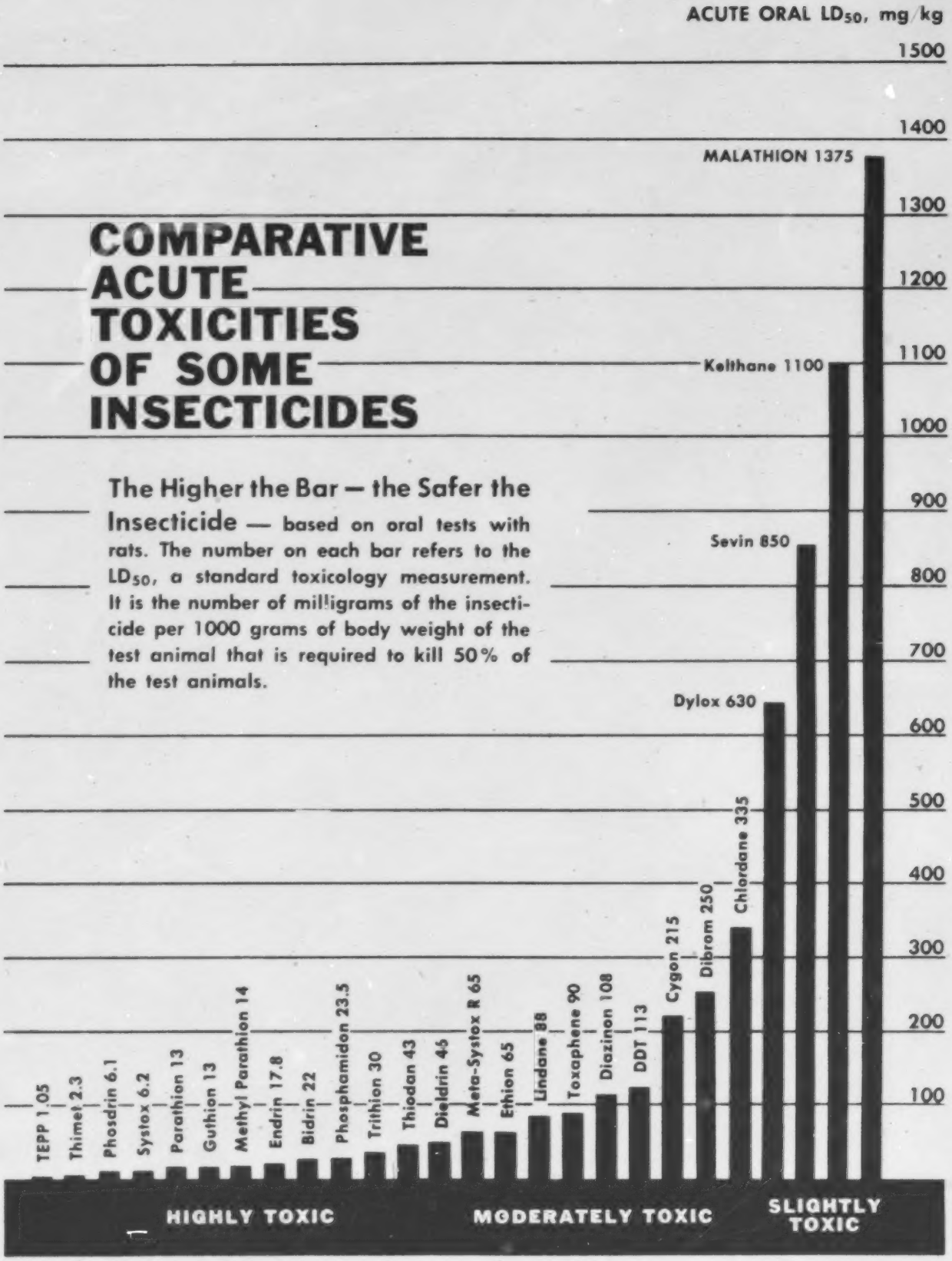
C. Analyze chemical labels.

IV. Suggested Teaching Materials

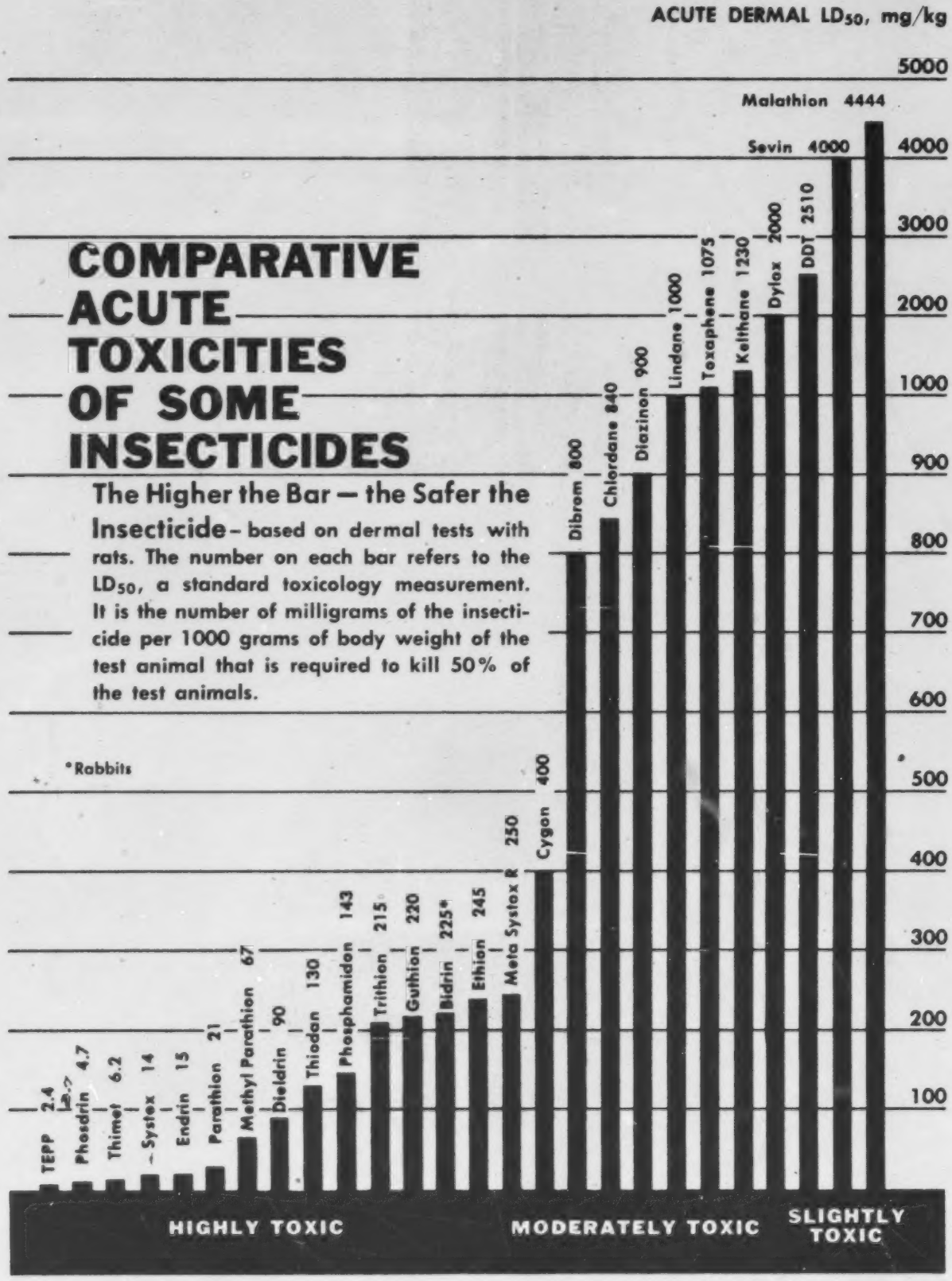
A. References for Lesson 2
1. Crops and Soils, August-September, 1969, pp. 11-12.
2. Farm Technology and Agrifield Man, pp. 22-26.
3. Farmer's Guide for Safe Crop Spraying, Bulletin, Misc. 335.
4. Kentucky Pesticide Use and Application Act, pp. 2-18.
5. Safety Handbook, pp. 1-33.
6. Supplied Packet of J. C. Materials.
7. Twenty-fifth Illinois Custom Spray Operators Training School, pp. 181-187, 300-304.

B. Resource personnel
1. For specific personnel see VoAg Directory of Resource People in Kentucky.

C. Audio-visuals
1. Masters
-1 Comparative Acute Oral Toxicities of Some Insecticides
-2 Comparative Acute Dermal Toxicities of Some Insecticides
-3 Danger -- LD/50 of Common Farm Chemicals
-4 Pesticide Toxicity Classes and the Amount of Substances Effective by Different Routes of Absorption
-5 Comparative Toxicities of Soil Insecticides
-6 Pesticides and the Human Body
-7 Food Chain
-8 How to Read and Use the Niagara Label
2. Slides
a. "Safety"
b. "Rinse and Drain"


ACUTE ORAL LD50, mg/kg
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
COMPARATIVE ACUTE TOXICITIES OF SOME INSECTICIDES
The Higher the Bar — the Safer the Insecticide — based on oral tests with rats. The number on each bar refers to the LD50, a standard toxicology measurement. It is the number of milligrams of the insecticide per 1000 grams of body weight of the test animal that is required to kill 50% of the test animals.
MALATHION 1375
Kelthane 1100
Sevin 850
Dylox 630
Chlordane 335
Dibrom 250
Cygon 215
DDT 113
Diazinon 108
Toxaphene 90
Lindane 88
Ethion 65
Meta-Systox R 65
Dieldrin 46
Thiodan 43
Trithion 30
Phosphamidon 23.5
Bidrin 22
Endrin 17.8
Methyl Parathion 14
Guthion 13
Parathion 13
Systox 6.2
Phosdrin 6.1
Thimet 2.3
TEPP 1.05
HIGHLY TOXIC
MODERATELY TOXIC
SLIGHTLY TOXIC

109-2-1



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109-2-2

DANGER? LD_{50} of common farm chemicals measured in milligrams of substance per kilogram of body weight.

Pesticide	Oral	Dermal	Use
phorate (Thimet)	1.7	4.4	insecticide
parathion	8.3	14.0	insecticide
nicotine	10	140	insecticide
endrin	12.7	16.5	insecticide
methyl parathion	19	67	insecticide
Trithion	20	40	insecticide
Guthion	20	220	insecticide
Paris green	22	——	insecticide
strychnine	30	——	rat poison
mercury seed treaters	37	——	seed protectants
DNBP (dinitro compounds)	40	——	weed killer
dieldrin	46	75	insecticide
kerosene	50	——	fuel
sodium fluoride	75	——	insecticide
rotenone	83	943	insecticide & fish poison
Diazinon	92	678	insecticide
lead arsenate	100	2,400	insecticide
PCP (Penta)	100	100	wood preservative
Ciodrin	125	385	insecticide
gasoline	150	——	fuel
Warfarin	186	——	rat poison
caffein (coffee, tea)	200	——	coffee, tea
dimethoate (Cygon)	215	505	insecticide
Nemagon or Fumazone	250	1,420	nematocide
chlordane	283	765	insecticide
nabam	394	——	fungicide
carbaryl (Sevin)	675	4,000	insecticide
MCPA	700	——	weed killer
2,4-D	700	——	weed killer
aspirin	750	——	pain reliever
malathion	1,375	4,500	insecticide
ronnel (Korlan)	1,940	5,000	insecticide
pyrethrins	1,500	1,880	insecticide
linuron (Lorox)	1,500	——	weed killer
atrazine	3,000	——	weed killer
EPTC (Eptam)	3,160	——	weed killer
table salt	3,320	——	mineral food item
diuron (Karmex)	3,400	——	weed killer
amiben	3,500	——	weed killer
trifluralin (Treflan)	3,700	——	weed killer
ethyl alcohol	4,500	——	beverage
Borax	4,980	——	cleaning compound & insecticide
simazine	5,000	——	weed killer
bromacil (Hyvar-x)	5,200	——	weed killer
fenuron (Dybar)	6,400	——	weed killer
maneb	6,750	——	fungicide
piperonyl butoxide	7,500	1,880	insecticide
captan	15,000	——	fungicide

SOURCE: CROPS & SOILS MAGAZINE/AUGUST-SEPTEMBER '69

109-2-3

Pesticide Toxicity Classes and the Amount of Substance Effective by Different Routes of Absorption[a/]

Commonly used term (toxicity class or rating)	Routes of Absorption		
	LD/50-single oral dose, rats mg/kg	LD/50 single dermal dose, rabbits mg/kg	Probable lethal oral dose, man (signal word)
Extremely toxic (1)	1 or less[b/]	20 or less	A taste, a grain[c/] (POISON-DANGER)
Highly toxic (2)	1-50	20-200	A pinch, ½ teaspoon (POISON-DANGER)[c/]
Moderately toxic (3)	50-500	200-1,000	1 teaspoon-2 tablespoons (WARNING)
Slightly toxic (4)	500-5,000	1,000-2,000	1 ounce- 1 pint (CAUTION)
Practically non-toxic (5)	5,000-15,000	2,000-20,000	1 pint- 1 quart (NONE)
Relatively harmless (6)	15,000+	20,000+	Greater than 1 quart (NONE)

a/ Modified after Bailey, J.B., and J.E. Swift. 1968. *Pesticide Information and Safety Manual*. University of California Press. Berkeley.

b/ Of the pure, undiluted compound.

c/ Any compound having the signal words POISON-DANGER must also have the skull and crossbones symbol on the package label.

Note: 1 kilogram (kg)=2.2 pounds (lb) 28.3 grams (gm)=1 ounce (oz.)
1000 milligram (mg)=1 gram (gm)

SOURCE: Illinois Custom Spray Guide.

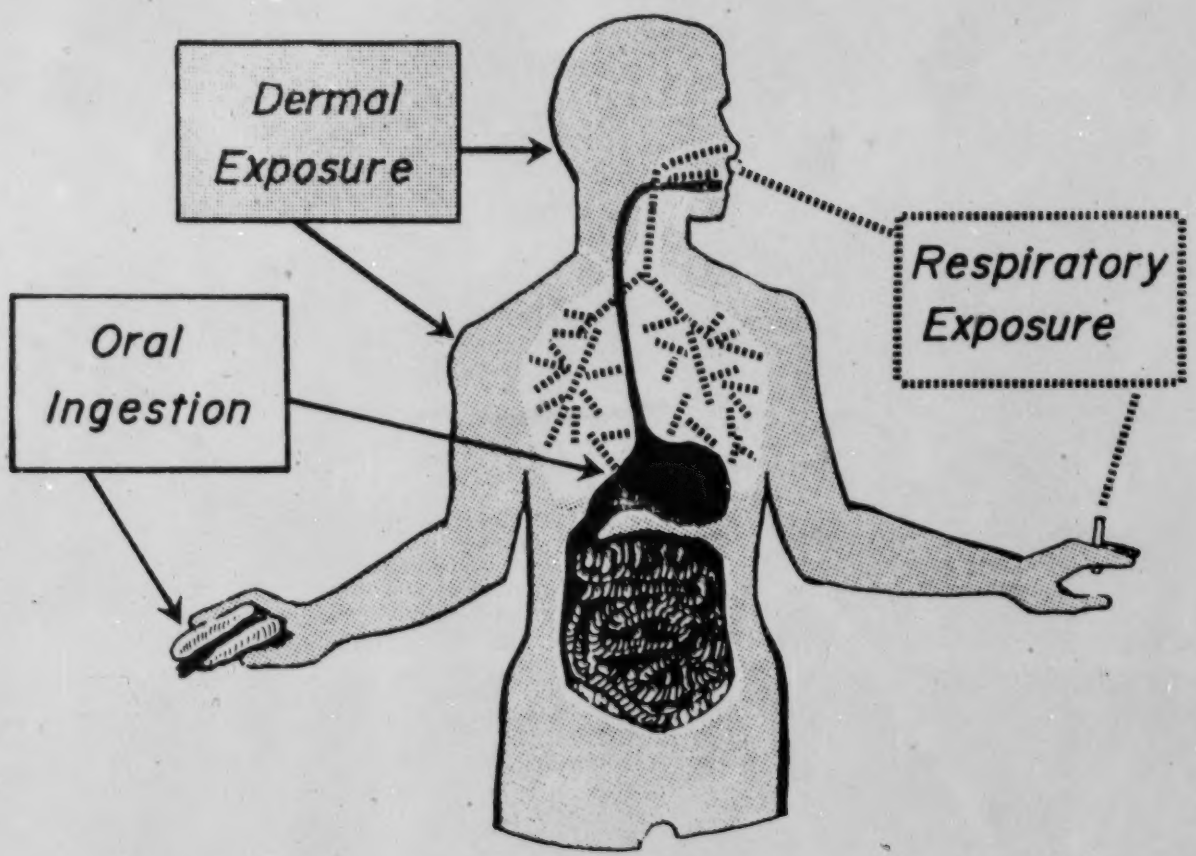
COMPARATIVE TOXICITIES OF SOIL INSECTICIDES:

Pesticide	Toxicity (mg/kg)	
	Oral	Dermal
Aldrin	39-60	98
Bux Ten	87	400
Dasanit	2-11	3-30
Diazinon	76-108	455-900
Di-Syston	2-7	6-15
Dyfonate	16	
Furadan	11	10,500
Parathion	4-13	7-21
Thimet	1-3	3-6

Source - Illinois Spray Guide

PESTICIDES and the HUMAN BODY

ROUTES of ENTRY

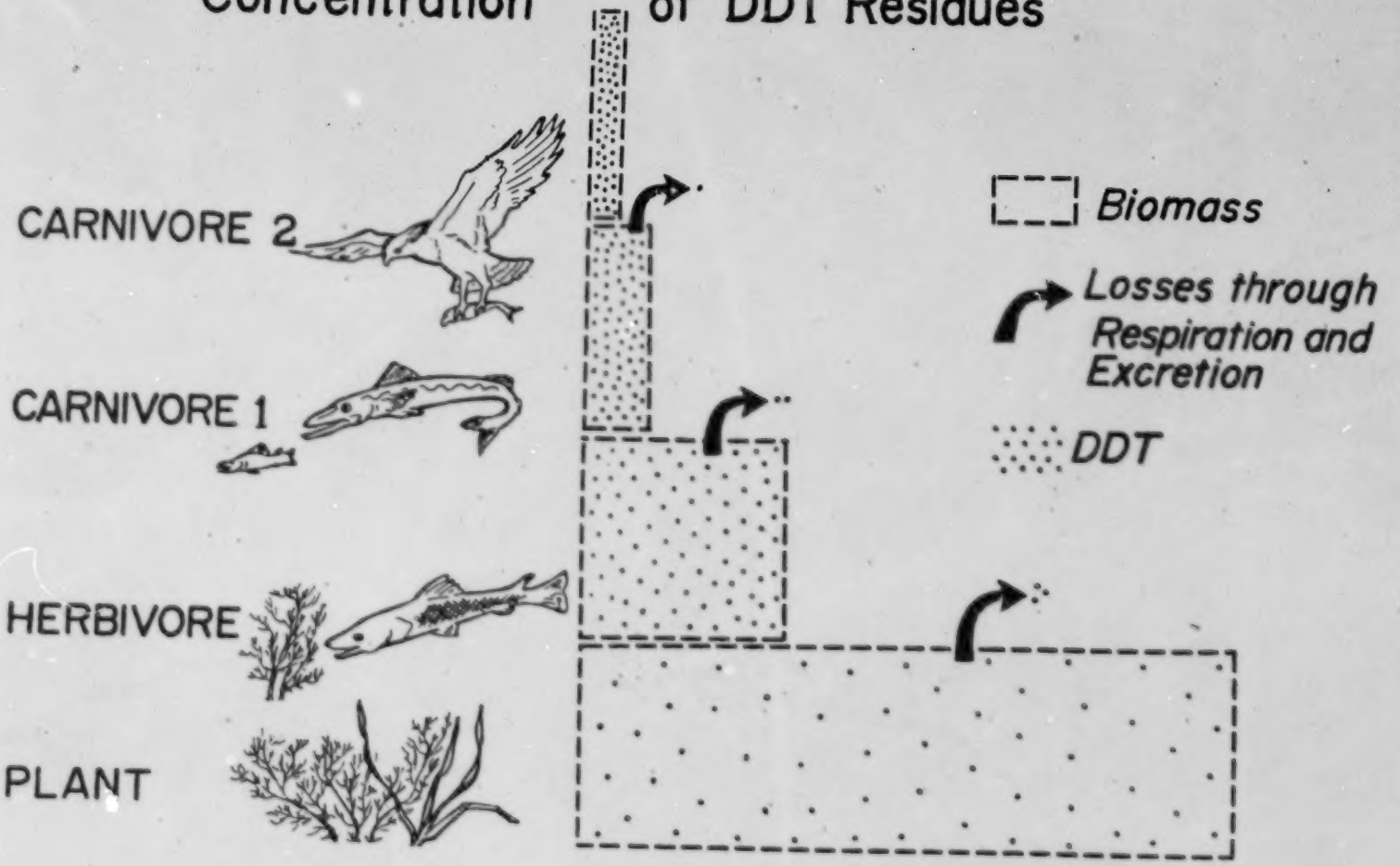


SOURCE: The Ecology of Pesticides

109-2-6

FOOD CHAIN

Concentration of DDT Residues



From Scientific American, (March, 1967)

SOURCE: The Ecology of Pesticides.

Lesson 3

DEVELOPING A COMPREHENSIVE PEST CONTROL PROGRAM

Objective -- To develop the effective ability of applicators to develop a comprehensive pest control program.

Problem and Analysis -- What are the requirements for a good pest control program?

-Proper identification of pests
-Timeliness
-Thoroughness
-Equipment
-Proper materials

Content

I. Proper Identification of Pests

A. Recognition or identification of the pest(s) to be controlled is of primary importance in establishing a sound pest control program.

B. We must develop, as far as possible, the capability to recognize and identify the pest and the symptoms of damage or injury they cause.

C. If unable to properly identify the pest causing injury or damage, we should call in a specialist for assistance in diagnosis of the problem.

D. The major areas of concern in pest identification are as follows:
1. Weed identification
2. Insect identification
3. Plant-disease identification

II. Timeliness of the Pest Control Program

A. Pesticide labels generally indicate under

Directions for Use when to apply first and/or successive applications to maintain control of the pest(s).

B. Due to variations in seasonal advances, specific dates to apply some pesticides are not a desirable measure for timeliness of application.

C. Where tolerances on residues are to be met, always observe the recommended number of days interval between last application and harvest. This is especially important today since tolerances can be checked as low as one part per billion (PPB).

D. Further information for timing of the pest control programs is available from the Cooperative Agricultural Extension Service. Practically all commercial guides include recommendations on timeliness of application.

III. Thoroughness of Coverage

A. Soil pesticide labels generally indicate under Directions for Use the degree of coverage to provide. When thorough coverage is not provided as recommended, the results will be unsatisfactory control.

B. Failure to provide thorough coverage can result in the following:
   1. Poor control
   2. Re-infestation of insects
   3. Re-infestation of weeds
   4. Re-infection of disease

C. To insure thorough coverage, use the amount of water recommended on the label with formulations of liquid or emulsifiable concentrates, soluble powder and wettable powders. To use less water than is recommended reduces thoroughness of coverage. Water is the least expensive item of a good pest control program.

D. To insure thorough coverage:
   1. Pesticides formulated as a dust should be

applied at the rate recommended, giving particular attention to areas to be covered.

2. Pesticides formulated as granules should be applied at the recommended rate, and the applicator properly calibrated for accuracy.

E. In addition to labels for thoroughness of coverage, see the recommendations of the Cooperative Agricultural Extension Service.

IV. Good Equipment

A. The job of the pesticide application equipment is to deliver the pesticide at proper rates to the area infested by the pest; ideally, for the most "kill" with the least amount of pesticide.

B. Proper use of the equipment is essential for efficiency of any dusting or spraying operation. In many cases, improper use of the equipment results in poor control of pests. Then too often the pesticides are blamed for the failure of the control program. In the case of insect control, the location of the pests on the plant determines how the equipment should be adjusted.

C. Sprayers--There are two basic types of so-called general farm sprayers: Boomless, and Boom-Equipped. Either of these is available with a variety of pumps and carriers. They can be tractor mounted or trailer mounted. There is a difference in versatility of the two types mentioned. A brief description of the two types are as follows:

1. Boom sprayers
   a. Whether the spraying job calls for low or high pressures, the boom sprayer will apply pesticides where they are wanted.
   b. Usually set up with nozzles spaced on 20" center, a 20' to 28' boom is ideally suited for all types of insect, disease and weed control.
   c. When purchased with standard equipment, a boom sprayer comes equipped for an

overall or blanket spray for weed and insect control in nearly all crops and for weed control in corn under 12" high.

d. For a more select program in vegetables, corn over 12" high, cotton lay-by weed control, and others, drop-pipes and nozzle clusters can be purchased that will permit a selective application program.

e. By adding a handgun and a length of hose, additional jobs can be performed, such as to:
   1) Fight grass fires (with due consideration of pressure limitations)
   2) Disinfect buildings
   3) Spray livestock
   4) Clean equipment
   5) Spray small orchards, trees, and shrubs
   6) Spot-spray weeds and brush

2. Boomless sprayers
   a. This type of sprayer is primarily designed for use where selective spraying and possible injury to adjoining crops are not problems.
   b. Its broad spray swath--dispersed by a cluster of nozzles or a single special nozzle--permits fast coverage in such crops as small grains, forage crops, pasture lands and corn under 12" high.
   c. Complete coverage is somewhat of a problem because of drift tendency. The pattern is at the mercy of prevailing ground winds.
   d. A boomless sprayer may be sufficient for spray jobs listed above.

3. Air Blast Sprayers (sometimes referred to as "speed sprayers") are a specially designed boomless type used for spraying in commercial orchards or situations requiring a high degree of lift of the pesticides. Air blast sprayers are primarily designed to carry pesticide-water mixtures (in various concentrations) under pressure from a pump through a series of nozzles into an accelerated air stream that blows into the tree

by means of a fan (centrifugal or axial flow).

a. Sprayers of this type can be power operated by an air cooled motor or power take-off from the tractor. The smaller size sprayers are usually powered by tractor PTO.

b. There are many manufacturers of air-blast sprayers with many variations in size and type. Three general types are recognized on the basis of volume applied.

1) Full-dilute machines--Apply 400-1200 gallons per acre.

2) Semi-concentrate or semi-dilute sprayer--Can apply 125-300 gallons per acre.

3) Concentrate sprayers--Apply 10-100 gallons per acre. Concentrate sprayers may be classified by air volume and discharge velocity:

a) Low volume, low pressure
b) Low volume, high pressure
c) Low volume, moderate pressure, high speed air
d) Medium volume, low pressure
e) Medium volume, high pressure

c. Check operator's manual for calibration procedures.

D. Sprayer pumps

1. Three factors in selecting the proper pump for a sprayer are:

a. Capacity. The pump should be of proper capacity or size to supply the boom output and to provide for by-pass agitation. The boom output, depending upon the number and size of nozzles, plus 50 percent or more for agitation return is recommended. Capacities of pumps are given in gallons per minute or per hour.

b. Pressure. The pump must produce the desired operating pressure for the job of spraying to be done. Pressures are indicated in pounds per square inch (PSI).

c. Resistance to corrosion and wear. Most pesticides are of a corrosive nature, and powders are abrasive.

2. For types of pumps, operating pressures and principal features, see Chart at end of lesson on Field Crop Sprayers.
   a. Over the years the roller pumps have been the most commonly used pumps.
   b. Centrifugal pumps are next in popularity.

E. Tanks
1. Present day farming operations require large-size tanks to reduce time required for filling and transport time to areas being sprayed. (Lack of sufficient tank size is probably one of the contributing factors to using insufficient quantities of water.)
2. Trailer sprayers permit the use of larger tanks and instant hookup with a tractor for spraying.

F. Agitator
1. In some instances of poor pest control the fault can be traced back to poor agitation of spray solutions. Pesticides that remain only in suspension require constant agitation. Therefore, since many of the pesticides are wettable powders, provision for agitators should be a necessity.
2. A few companies now make special low-cost equipment such as Jet Agitators, Volume Booster, or Submerged Electrically-Operated Pumps to provide additional agitation other than that obtained through the by-pass alone.

G. Other essential accessories:
1. Combination pressure-control assemblies consist of pressure regulator valve, pressure gage (in PSI) and quick shutoff valve. These controls should be easily accessible from the tractor seat.
2. Hose and fittings should meet the following requirements:
   a. Quality and strength to handle pesticides and operating pressures to be used

b. Strong, sturdy, resistant to deterioration and general abuse.
c. Proper size hose to match pump capacity

3. Strainers. Clean tanks, clean water and properly mixed spray materials will do much to prevent clogged nozzles, strainer and pump damage. Strainers should always be used at least in the suction line and at the nozzles. Most strainers are of two types; slit or wire-mesh. Mesh-size varies. Where wettable powders are used a 50-mesh screen is generally used. For other formulation a 100-mesh screen is recommended.
4. Nozzles
   a. The selection of nozzles designed to develop various spray patterns, rates of discharge, angles of spray and wear capabilities are very important in getting good equipment performance. Users have found in application that the nozzle material most economical in the long run in terms of nozzles and chemical costs and spraying effectiveness is that material which offers the greatest resistance to corrosion and erosion relative to chemical used. (See at end of lesson.)
   b. For the selection of nozzles with different spray patterns, rates of discharge and degree of angle discharge, a manufacturer's catalog would be very helpful (note Reference). Nozzle identification based on spray patterns are as follows:
      1) Nozzles with flat spray tips
      2) Nozzles with even spray tips
      3) Nozzles with wide-angle, flat-spray, flood-jet tips
      4) Nozzles with cone spray tips (hollow and solid cone)
      5) Nozzles for special applications
5. Calibration
   a. Sprayer calibration is an essential operation in further assurance of a good pest control program. Sprayer

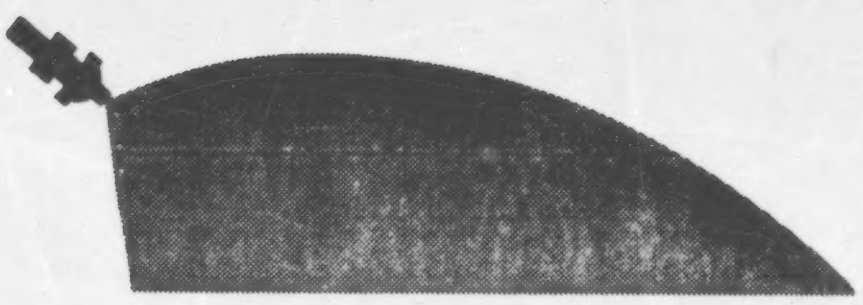
calibration is simply determining the amount of pesticide being applied to a given surface or area. It is the final step in preparing a sprayer for a specific spraying job and is a check to determine if the selected nozzle tips, operation pressure, and ground speed actually give the desired rate of application.

b. Basic factors to consider in calibration. The amount of a liquid that a sprayer applies to a given area can be varied by changing one or more of the following:
   1) Pressure that forces liquid through nozzle tip
   2) Nozzle orifice (tip opening) size
   3) Sprayer ground speed (speed with which nozzle passes over surface)
   4) Spacing of nozzle on boom or width of spray pattern

c. Calibration procedure calculation Methods vary from university to university, manufacturer to manufacturer. Following manufacturer's manual on calibration of equipment is of course desirable. Where such instructions are not available with the equipment, our alternative is to select a method from one of the universities.

d. Basically, the following two methods provide a means for calibrating practically every type of spray unit or spraying operation: (Both methods are suitable for boom sprayers.)
   1) The total-sprayer-volume method consists of spraying with water over a given distance in a field with a sprayer and measuring the amount of water used. This method must be used for boomless sprayers.
   2) The nozzle-volume involves using a container to measure the discharge from one or more nozzles while operating the sprayer over a given distance in a field. This method

NOZZLE TYPES



OFF-SET NOZZLE

SOURCE: Washington Pest Control Handbook.

is best where a small number of nozzles are used, such as band application. Nozzle size should remain consistent in a given spray system.

e. An example for calibration of application equipment is given at the end of the lesson.

f. Maintenance, care, and cleaning of sprayers are essential for good operating equipment. Study the Owner's Instruction Manual for the above situations.

V. Proper Materials

A. Only after the identity of the pest is known can we make proper selection of the materials to use. In most instances there is some leeway in the selection of materials to use. Pesticides are applied for one of two purposes:
   1. As a preventive measure.
   2. As a corrective or eradicative measure.

B. Factors that provide flexibility in selection of proper materials to use are:
   1. Toxicity variance (high to low LD_{50} materials)
   2. Formulations. In some instances wettable powders are safer to use on foliage applications.
   3. Residues. Proper selection of material can sometimes allow avoidance of persistent residues.
   4. Substitution of materials, to keep within allowable tolerance.
   5. Combinations, to increase pest control effectiveness.
   6. Selection of pesticides for specific or broad-spectrum control.

C. For assurance of selecting the proper material for the job, always check the pesticide label under Directions for Use.

D. Check the Cooperative Agricultural Extension Service recommendations for proper material to use

for a given pest problem.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
1. The main areas of pest control programs that will be needed to carry out on-the-home-farm will be weed, insect and disease control.
2. Identifying weed, insects, and diseases is an essential part of a pest control program.
3. Any pest control program to be effective requires:
a. That materials be used at the right time
b. That materials be applied thoroughly
4. Providing good equipment to effectively and accurately distribute the pesticides.
5. The proper selection of pesticides is a must in order to secure good control.

B. Things to be brought out by the students:
1. Problems encountered in past pest control programs
2. Successes encountered in previous pest control programs
3. Problems encountered in positive pest identification
4. The need for greater skills in pest identification

II. Conclusions:

A. When individually unable to identify the pest problem, secure the help of an Agricultural Extension Service specialist.

B. Timeliness and thoroughness are essential components of a good pest control program, and this information is available from the label or from Extension Service recommendations.

C. Good equipment is essential for proper distribution and applying the recommended rate of material.

D. The selection of proper material for the pest to be controlled is the key to pest control.

III. Enrichment Activities

A. Have on hand at meeting sample containers of herbicides, insecticides, fungicides secured from local dealer.

B. Have dealer bring in spray rig to show for inspection of group.

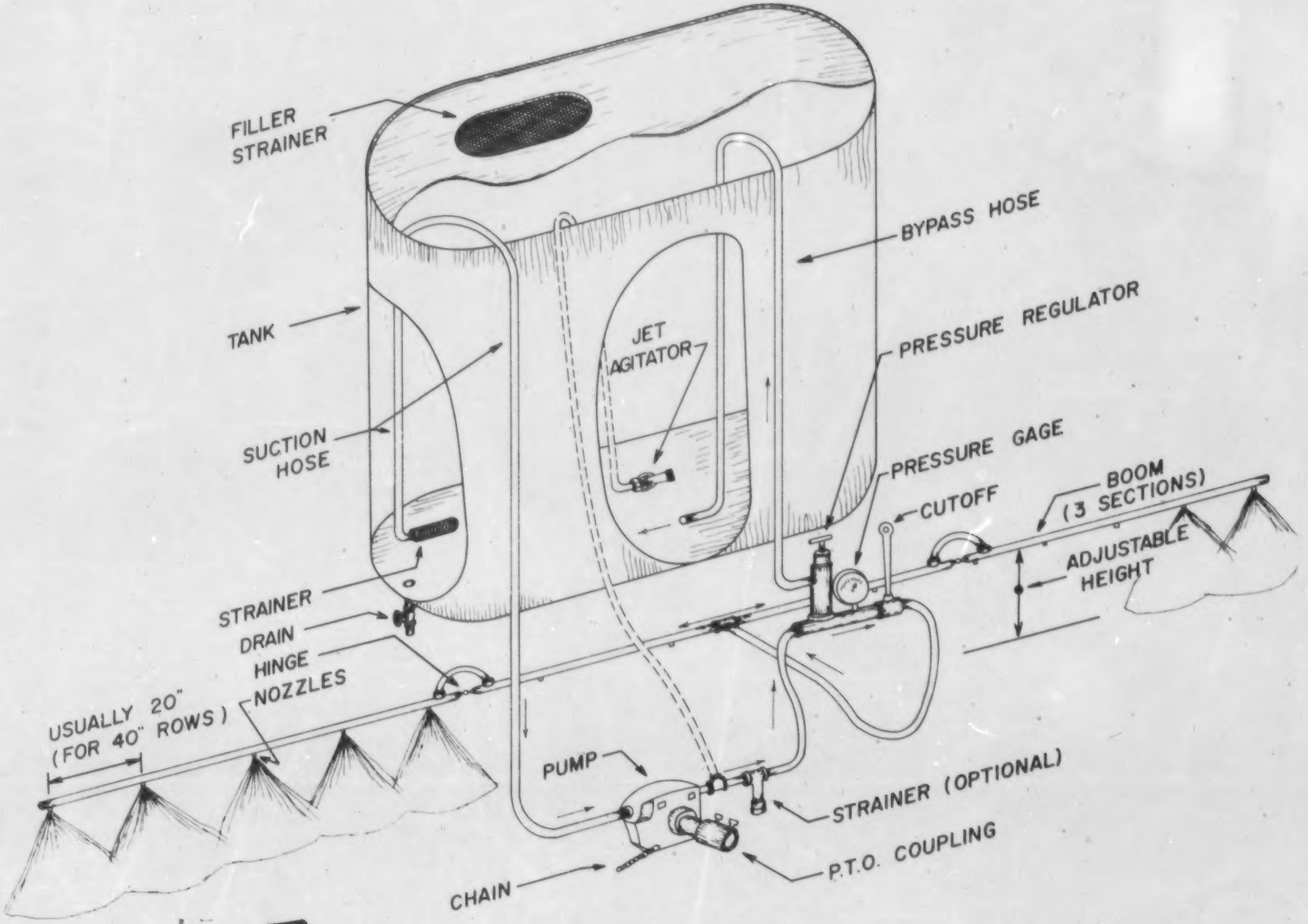
C. Have available Red-Top Farm Service Slide Rule used in sprayer calibration problems.
(Available from Agricultural Chemical Division of
Wilbur-Ellis Company
Old Highway 99 at Cedar
P.O. Box 1286
Fresno, Calif. 93715
Approximate cost is $7.50.)

IV. Suggested Teaching Materials

A. References for Lesson 3
1. Agricultural Spray Nozzles and Accessories, Catalog #35, pp. 2-10.
2. Chemical Control of Weeds in Farm Crops in Kentucky, 1973.
3. "Field Crop Sprayer," Kentucky Agricultural Engineer, pp. 20-38.
4. Specimen labels.

B. Resource personnel
1. For specific personnel, see VoAg Directory of Resource People in Kentucky.

C. Audio-visuals
1. Masters
-1 Basic Parts of a Field-Crop Sprayer
-2A,B Nozzle Matching and Nozzle Alignment
-3A-C Boom Conditions and Nozzle Effects
-4A-E Nozzle Types
-5 Handgun and Assembly
-6 Increase in Discharge of Nozzles
-7 Calibration of Application Equipment

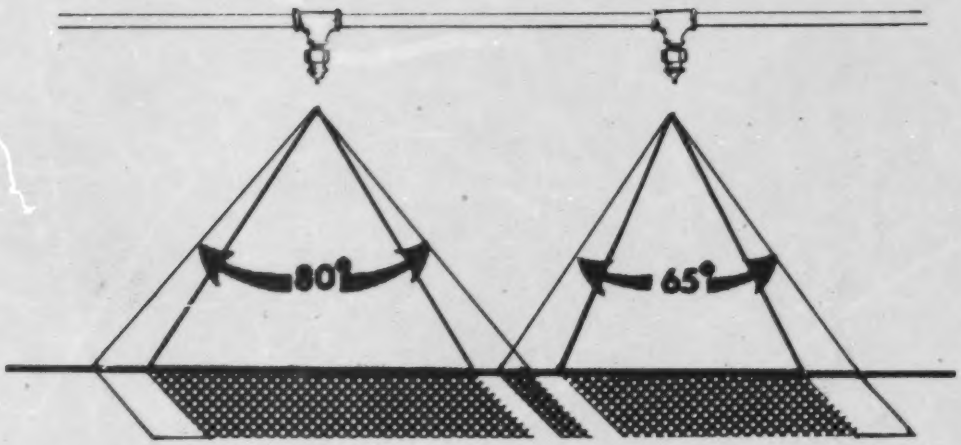


BASIC PARTS OF A FIELD-CROP SPRAYER

SOURCE: Kentucky Agricultural Engineer

109-3-1

NOZZLE MATCHING AND ALIGNMENT



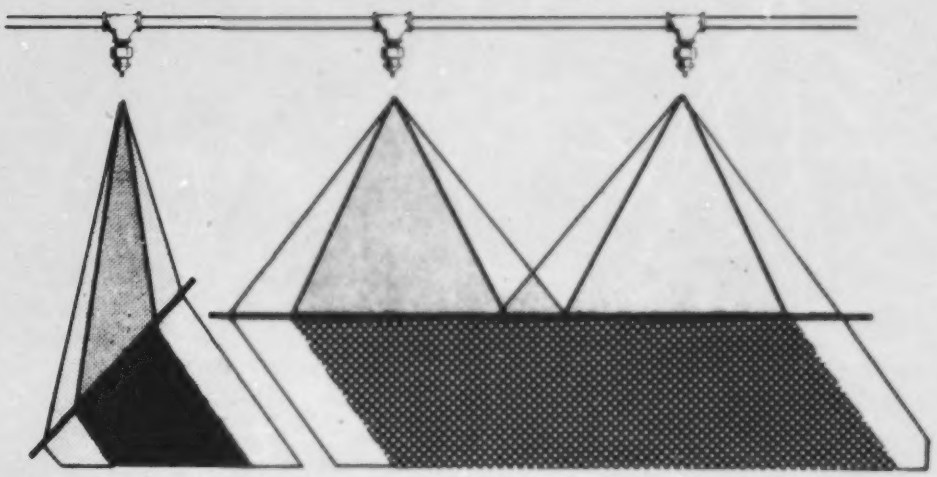
DO NOT USE 80° and 65° NOZZLES TOGETHER

SOURCE: Washington Pest Control Handbook.

109-3-2A

W.O. 1048-1

NOZZLE MATCHING AND ALIGNMENT



NOZZLES SHOULD BE ALIGNED PARALLEL WITH THE BOOM

SOURCE: Washington Pest Control Handbook.

109-3-2B

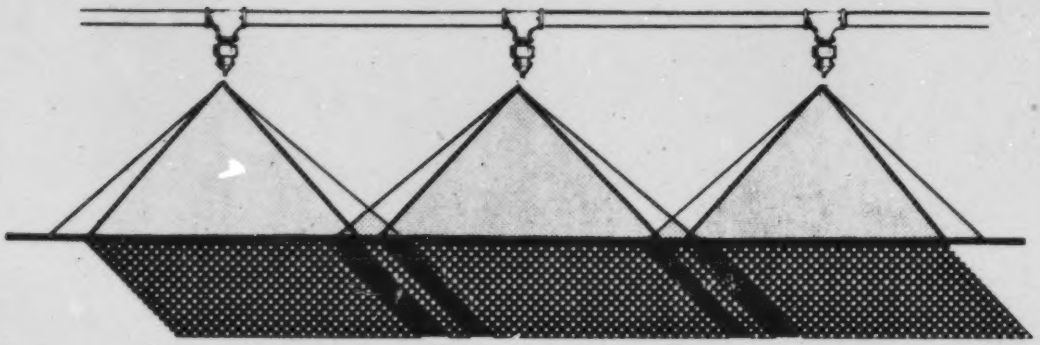
BOOM CONDITIONS AND NOZZLE EFFECTS

BOOM SHOULD BE LEVEL TO SPRAYED SURFACE
FOR UNIFORM COVERAGE

SOURCE: Washington Pest Control Handbook.

109-3-3A

BOOM CONDITIONS AND NOZZLE EFFECTS



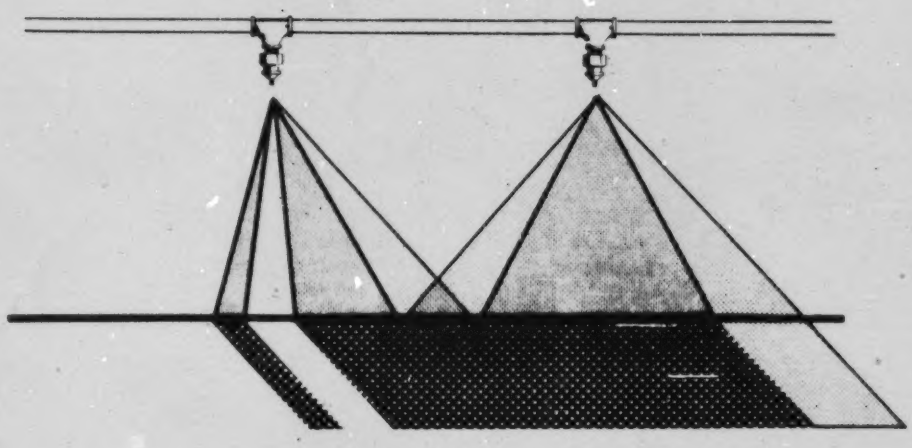
BOOM TOO LOW OR TOO HIGH WILL GIVE UNEVEN PATTERNS

SOURCE: Washington Pest Control Handbook.

109-3-3B

WO. 1048-4

BOOM CONDITIONS AND NOZZLE EFFECTS

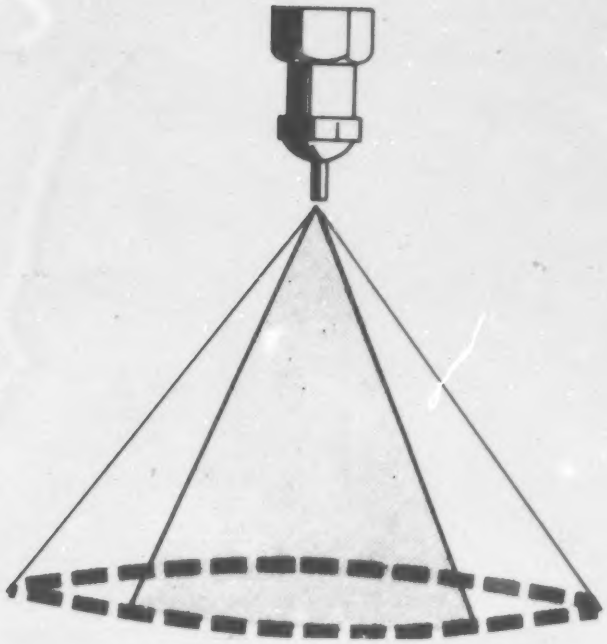


WORN OR PLUGGED NOZZLES GIVE UNEVEN APPLICATION

SOURCE: Washington Pest Control Handbook.

109-3-3C

NOZZLE TYPES



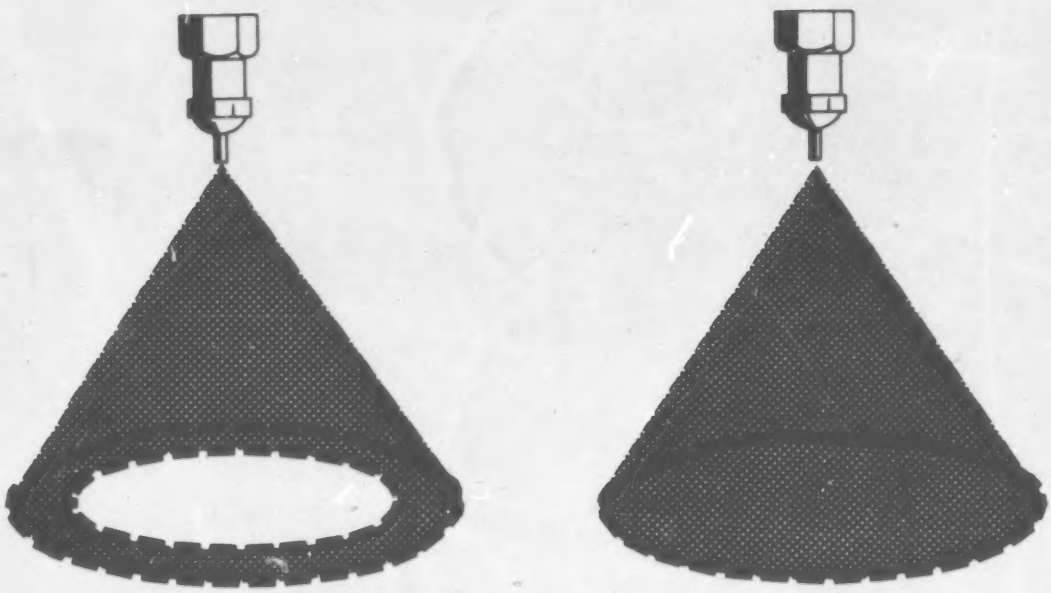
FLAT-SPRAY NOZZLE

SOURCE: Washington Pest Control Handbook.

109-3-4A

w.o. 1048-6

NOZZLE TYPES

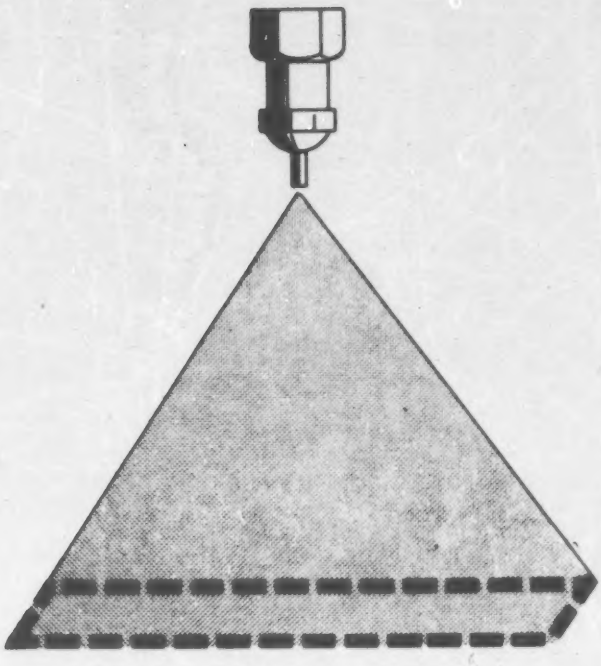


CONE NOZZLES

SOURCE: Washington Pest Control Handbook.

109-3-4B

NOZZLE TYPES



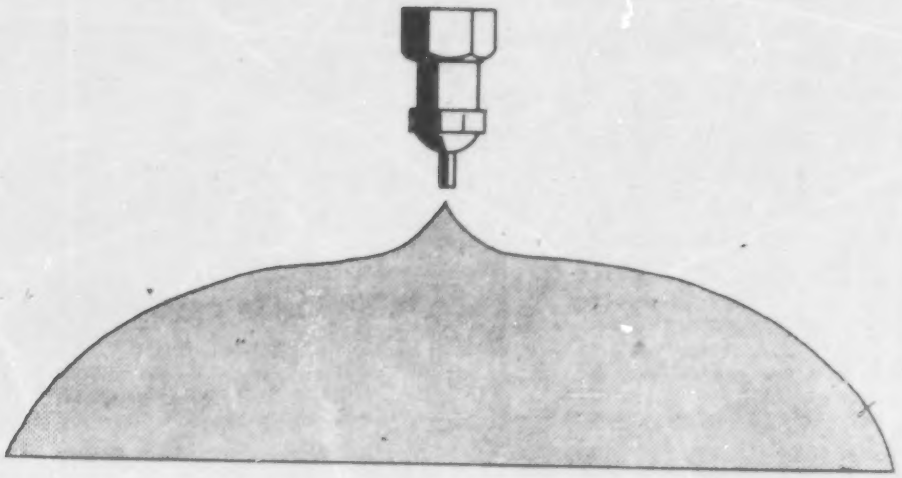
EVEN-SPRAY NOZZLE

SOURCE: Washington Pest Control Handbook.

109-3-4C

W.O. 1048-8

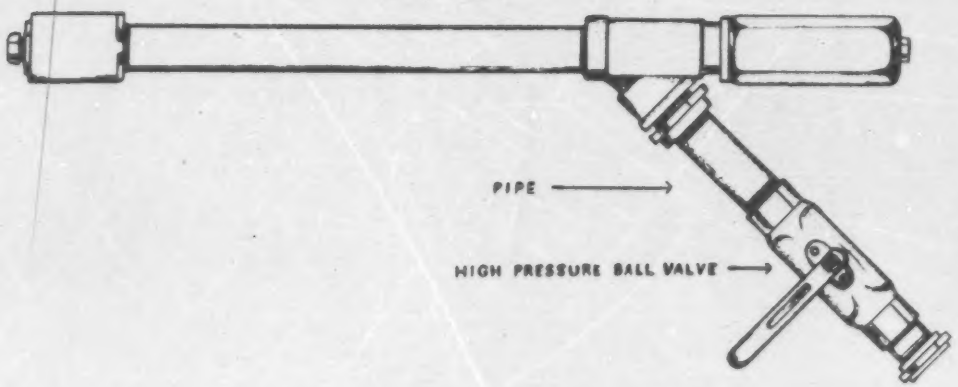
NOZZLE TYPES



FLOODING NOZZLE

SOURCE: Washington Pest Control Handbook.

HAND GUN ASSEMBLY OFTEN USED BY ORNAMENTAL SPRAYERS



SOURCE: Washington Pest Control Handbook.

109-3-5

WO. 1048-12

INCREASE IN DISCHARGE OF NOZZLES

Nozzle size	Nozzle type	Number of tests	Range in percent increase	Average percent increase
8002	Brass	15	0.62 - 6.60	3.74
8002SS	Hardened stainless steel	2	0.64 - 0.65	.65
8003	Brass	16	0.83 - 8.18	4.30
8003E	Brass-band spray	3	6.14 - 7.83	6.94
8003SS	Hardened stainless steel	3	0.00 - 0.88	.57
8004	Brass	6	3.90 - 5.96	5.17
8004E	Brass-band spray	3	5.78 - 6.54	6.27
8004SS	Hardened stainless steel	3	1.05 - 1.38	1.26

[1]Result of 2# w.p. in 20 gals. of water at 40 PSI.

NOTE: Researchers recommend daily calibration and replacement of excessively worn tips.

SOURCE: University of Tennessee.

109-3-6

CALIBRATION OF APPLICATION EQUIPMENT

Rate of application, granular and sprays, may vary with materials used. Application equipment must be calibrated for each material applied to obtain accurate delivery. Here are suggested steps to calibrating three types of applicators.

BOOM SPRAYER

1. Clean sprayer and replace all worn or defective parts.
2. Fill tank with water.
3. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
4. Spray ¼ acre (10,890 sq. ft.). Distance of travel will vary with boom width. For example, a 22 ft. boom must travel 495 ft. to cover ¼ acre:

$$\frac{\text{¼ acre (10,890 sq. ft.)}}{\text{Boom width (22 ft.)}} = \text{distance of travel (495 ft.).}$$

5. Measure amount of water needed to refill the tank. This amount was applied to the ¼ acre; thus, four times this amount is the gallonage per acre.
6. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
7. Calculate acres covered by tank of spray solution, and add required amount of herbicide for total area to be sprayed.

BAND SPRAYER

1. Clean sprayer and replace all worn or defective parts.
2. Fill tank with water.
3. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
4. Spray ¼ acre (10,890 sq. ft.). Distance of travel will vary with number of rows on the planter and row width. For example, band spraying over 4 rows spaced 40 inches requires 817 ft. to cover ¼ acre:

$$\frac{\text{¼ acre (10,890 sq. ft.)}}{\text{Rows (4) x row width (3.33 ft.)}} = \frac{\text{10,890 sq. ft.}}{\text{13.33 ft.}} = \text{distance of travel (817 ft.).}$$

5. Measure amount of water needed to refill the tank. This amount was applied to the ¼ acre; thus, four times this amount is the gallonage per acre.
6. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
7. Calculate acres covered by tank of spray solution, and add required amount of herbicide for total *actual* area to be band treated.

GRANULAR BAND APPLICATOR

1. Set applicator dial or dials to give desired delivery rate of granules, suggested for band treatment, according to manufacturer's instructions.
2. Fill hoppers with granules to be used.
3. Travel across field at planting speed for the distance required to cover $\frac{1}{78}$ acre (2,722 sq. ft.) per row. Collect granules for *each* row in a bag, bucket or other container. For example, granular band application for 40-inch row requires 817 ft. to cover $\frac{1}{78}$ acre:

$$\frac{\frac{1}{78}\text{ acre (2,722 sq. ft.)}}{\text{Row width (3.33 ft.)}} = \text{distance to travel (817 ft.).}$$

4. Weigh granules from each row separately, and multiply by 16 to find delivery per acre for each row.
5. Adjust each setting, and recalibrate until the desired delivery rate is obtained.

SOURCE: Purdue University.

[redacted]

WO. 1043-13

Lesson 4

UTILIZING HERBICIDES TO CONTROL WEEDS IN THE COMMONLY GROWN CROPS

Objective -- To develop the effective ability of farmers to properly utilize herbicides in controlling weeds in the commonly grown crops.

Problem and Analysis -- How should we use herbicides in controlling weeds in the commonly grown crops?

-Need for good weed control
-Importance of weed identification
-Principles of chemical weed control
-Method and time of treatment
-Types of formulations
-Planning a complete weed control program based on recommendations

Content

I. Need for Good Weed Control

A. Advances in weed control. Modern weed control had its beginning with the introduction of 2,4-D in the early 1940's. By 1946, investigation showed that 2,4-D had been used on a few thousand acres. Other developments occurring very rapidly and influencing advances in weed control were:

1. Development of a low-volume sprayer and immediate mass production.
2. Appearance of 2,4,5-T for brush control.
3. Fast recognition by the chemical industry of a new potential market; consequently a surge in research and development.
4. Steady drop in farm labor beginning after World War II

5. Continued acceptance of the need for good weed control by the producer

B. Advantages of herbicides as an economic farm management factor. Weeds are costly to agriculture producers. The average farm in the United States loses $500 per year from weeds. The economic advantages of chemical weed control can result from the following:
   1. Labor savings (cultivation)
   2. Lower equipment investment (in cultivating equipment)
   3. Increase in crop yield due to reduced competition of weeds for plant nutrients and water
   4. Better quality crops; increased market and feeding value
   5. Increased land values where weed problems do not seem evident
   6. Lower harvesting costs in weed-free crops

II. Importance of Proper Weed Identification

A. The method by which vegetation is controlled depends upon:
   1. The length of life of the plant
   2. The time of the year during which the plant grows
   3. The methods of reproduction

B. Plants are divided into three general types according to their length of life, annuals, biennials, and perennials.
   1. Annuals are a group of plants that complete their life cycle within one year. This means that, from the time of germination of the plant through growth and new seed production, the time is one year or less. Most common field weeds are annuals.
      Examples: foxtails, pigweed, cocklebur, morning glory, panicum.
   2. Biennials are a group of plants that live for more than one year, but not more than two. The seed production is generally accomplished the second year.
      Examples: wild carrot, bullthistle, and burdock.

3. Perennials--Both simple perennials and creeping perennials normally live for more than two years and reproduce by seed and/or vegetatively (creeping perennials).
   Examples: Johnsongrass, quackgrass and Canadian thistle.

C. To maintain weed control and reduce weed population of annuals and biennials, either of two approaches may be taken: either kill plants before seed reaches maturity or kill germinating seed or seedling present in the soil.
   1. One application of a proper herbicide with proper timing for the stage of development will usually aid in weed control.
   2. Perennials are harder and more expensive to control due to both seed and vegetative means of reproduction.
      a. Where spot treatment is advisable, one application of sodium chlorate, which sterilizes the soil for one or more years, would probably control a perennial like Johnsongrass.
      b. In situations where larger areas are involved, it would require three or more applications over an extended period of time.

III. Principles of Chemical Weed Control

A. How herbicides work. "Scientists Unlock Secrets of How Herbicides Work" was headlined in Agri-News, April, 1973. It was found that herbicides block an essential step in a plant's conversion of nitrogen into amino acids. Amino acids are so-called building blocks of protein and are essential to human and animal nutrition. Specifically, herbicides blocked nitrite (NO_2), a compound which the plant converts from the fertilizer form of nitrogen (NO_3), from completing its conversions to amino acids. In effect, herbicides disrupt this reaction and form an imaginary dam in the system causing a buildup of nitrites which eventually kill the plant.

B. Herbicide types
   1. Selective herbicides are those which kill or

damage some plants more than others. When applied at the recommended rate, selective herbicides usually control certain weeds with little or no injury to the crop.

a. Foliage applications are sprays applied to leaves of plants.
   1) Contact herbicides are those that kill only the part of the plant covered by the chemical.
   2) Translocated herbicides are those absorbed into the plant and translocated to other parts of the plant, both tops and roots.

b. Soil Applications may be pre-emergence or post-emergence; less damage occurs when sprayed before the crops come through the soil surface.

2. Non-selective herbicides are used when we intend to remove all or most of the plants within the treated area.
   a. Foliage applications
      1) Contact herbicides
      2) Translocated herbicides
   b. Soil applications
      1) Fumigants
      2) Sterilants
   c. Aquatic applications are herbicides put into the water to control weed growth.

IV. Method and Time of Treatment

A. Herbicides may be applied as follows:
   1. Pre-planting--on the soil before the crop is planted
   2. Pre-emergence--on the soil after planting, but before crops or weeds emerge
   3. Post-emergence--on weeds after weeds and crops are up
   4. Post-transplanting--on the soil after crop is transplanted, either before weeds emerge or after clean cultivation
   5. Directed post-emergence--on small weeds in rows of taller crops

B. Split application involves using two types of the above methods of application.
   Example: A pre-planting incorporated herbicide followed by a pre-emergence herbicide at planting time.

C. Factors affecting herbicide effectiveness when applied to foliage:

1. The leaf. The leaf is the main route of herbicide entry into the plant; therefore, condition of leaf surface, and humidity present determine how much chemical is retained and absorbed.
2. Rainfall. Rainfall prior to application of herbicide can be beneficial, but rainfall during or immediately after can reduce the effectiveness by washing the herbicide off the plant.
3. Soil moisture. Soil moisture affects plant turgidity. Plants with high moisture level have more carbohydrates in the leaf system than in the roots.
4. Temperature. Optimum temperature for most effective uptake of chemical would be that temperature providing the best growing conditions for the plant.
5. Light. The intensity of light and the light-dark relationship affects herbicide response, but its effect is only related to differences caused by weathering and abrasions of the leaves and the effect of crop competition.
6. Time of Day. The carbohydrate level in the foliage of a plant is lowest in the morning and highest in the middle to late afternoon. Morning applications should be more effective because the herbicide is on the leaf at a receptive time and enters in time to move with the manufactured food.
7. Age. At the early stage of plant growth, the reserve food supply in the roots of annuals is low; thus herbicides move with sugar and starches to the roots.
8. Nutrition. Herbicide injury to weeds is greatest when nutrient levels are high. The most success from herbicides occurs when both crops and weeds are growing vigorously.
9. Cultivation. More weed seeds germinate as a result of cultivation, consequently an appearance of better weed control may result when cultivated fields are sprayed.

D. Herbicide combinations. Tank-mix combination--Herbicide combinations are being used more inten-

sively. More will be available as experimental results show what the combinations are and label clearance can be obtained. Some factors influencing the use of combinations are:

1. Broader spectrum weed control
2. Longer seasonal control
   Example: Fall panicum which has a late germinating date as compared to early grasses such as foxtail or most annual broadleaf weeds.
3. Reduced herbicide carry-over of some persistent herbicides.

E. The roles of agricultural spray adjuvants and surfactants are firmly established; these materials improve the efficiency of pesticide chemicals.

1. Definitions:
   a. An adjuvant is defined as an ingredient which, when added to a formulation, aids the action of the toxicant. The term includes such materials as wetting agents, spreaders, adhesives, emulsifiers, dispersing agents, penetrants, and correctives.
   b. A surfactant is a "surface active agent." Its primary function is that of a wetting agent or as a component of an emulsifier or a spray adjuvant.
2. Functions of spray adjuvants--A spray solution may have one or more of the following functions to perform in order to provide a safe and effective application:
   a. Wetting of foliage and/or pest
   b. Modifying rate of evaporation of spray
   c. Improving weatherability of spray deposits
   d. Enhancing penetration and translocation
   e. Adjusting pH of spray solution and deposit to:
      1) Prolong life of alkaline sensitive pesticides
      2) Reduce re-entry time following application of hazardous chemicals
   f. Improving uniformity of deposit
   g. Improving compatibility of mixtures
   h. Providing safety to the treated crop

i. Reducing the drift hazard
j. Complying with F.D.A. requirements

NOTE: Products are available for all items above and on the previous page except e-l and h; these are experimental. For products, see suggested references.

V. Types of Formulations

A. Formulations. There are four main forms in which a farmer may buy herbicides:
Soluble liquid and solids
Emulsions
Wettable powders
Granules

1. Soluble materials are the easiest of the herbicides to handle in a sprayer. Materials do not settle out and no agitation is required.
2. Emulsions are made up of one liquid dispersed in another liquid. Emulsifying agents keep the two liquids in suspension, but require slight agitation.

NOTE: Always roll cans or drums prior to tank mixing. These materials will settle out.

3. Wettable powders are finely ground particles designed to be suspended in water for application. Wettable powders do require good agitation from tank mixing until material is applied.

NOTE: In tank mixing, make a slurry mix in a smaller container before adding to a partially filled sprayer tank.

4. Granules are a dry form of the chemical attached to carriers such as clay, sand, vermiculite or similar material and applied with a granule applicator.

VI. Planning a Complete Weed Control Program Based on Recommendations

A. Record keeping is essential in operating an efficient farm business. Keeping records of any pest control program should be an integral part of

record keeping. Today it is a must in some specialized types of farming.
Examples: Fruit and vegetable production.

B. Planning weed-control programs for the following areas should be considered:
   1. Controlling weeds within a specific crop
   2. Controlling specific weed problems
   3. Planning a weed-control program for the entire farm
   4. Determining the best herbicides to use

C. Incorporate in the plans, recommendations of the Agricultural Extension Service.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
   1. For economical production of crops, the use of herbicides will continue to play an important role. (Use Masters 1-5 and slide set.)
   2. Weed identification is essential before the herbicide can be selected.
   3. Herbicides are selective or non-selective in their mode of action.
   4. The method and timing of application are critical to weed control.
   5. Various formulations of herbicide compounds offer a degree of selectivity.
   6. Planning and keeping records of weed control programs is good business (Use Masters 6-10.)

B. Things to be brought out by class members:
   1. Participation in use of weed survey form in identifying problem weeds on the farm
   2. Success or failures in maintaining control of problem weeds

II. Conclusions

A. Herbicides are essential to competitively produce crops and improve the looks of our surroundings.

B. Weed identification is necessary in the selection of the proper herbicide.

C. Selecting herbicide types are important in controlling specific weed problems.

D. Method and time of treatment have much to do with the success of weed control.

E. In existing alternatives select the formulation that best fits the situation.

F. A planned weed-control program will greatly aid good weed-control.

III. Enrichment Activities

A. Invite local Extension Agent or Extension specialist to summarize experimental results of herbicide plot work nearest your area. (Interest runs very high in this topic.)

B. Herbicide Compatibility Chart -- note that many herbicides are of unknown compatibility.

IV. Suggested Teaching Materials

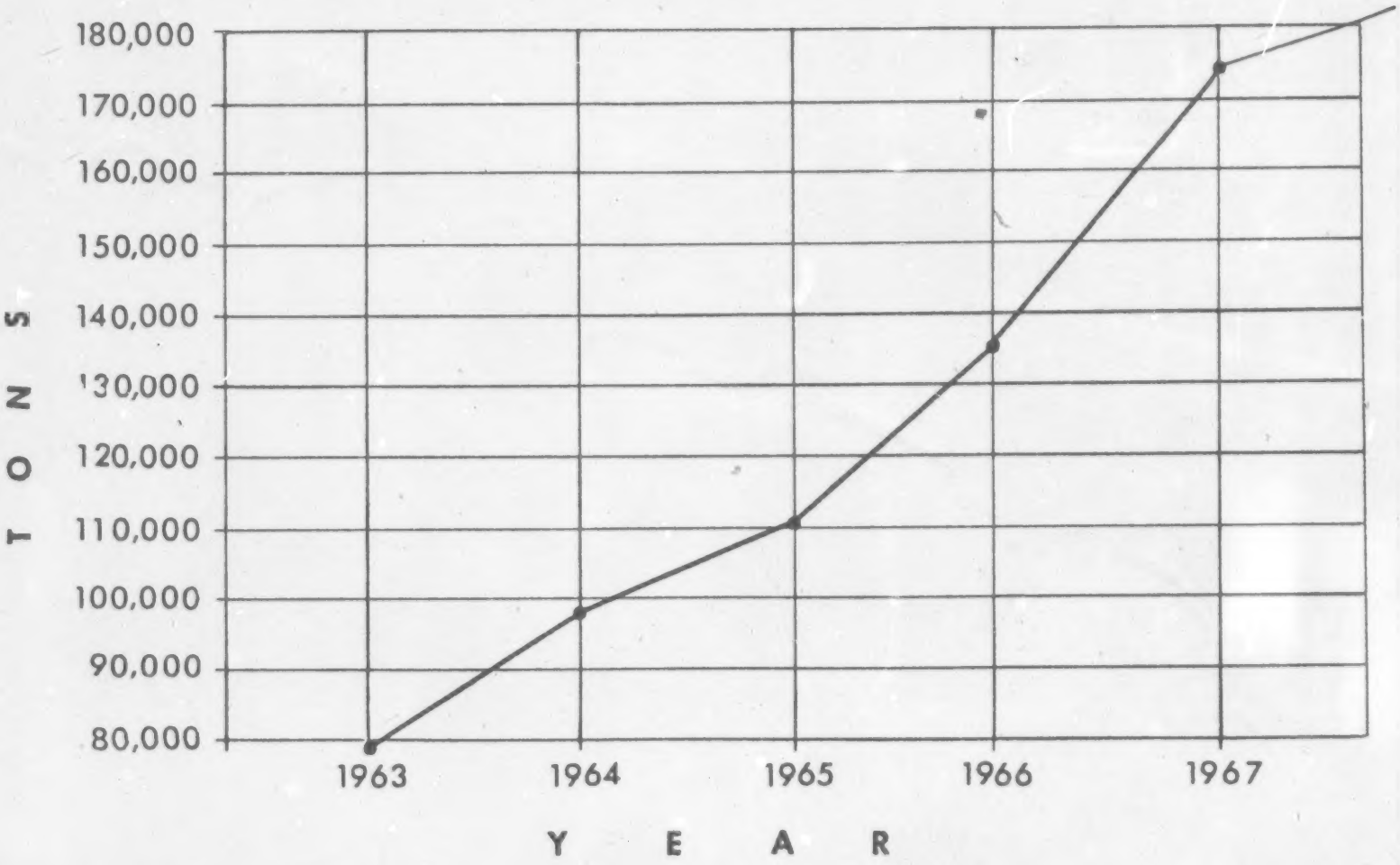
A. References for Lesson 4

1. Agri-field Man, February 1973, pp. 33-121.
2. Agri-field Man, summer 1973, pp. 16-17, 44.
3. Agri-News, April 1973, p. 1.
4. Chemical Control of Weeds in Farm Crops in Kentucky, 1973, AGR-6.
5. Crops and Soils Magazine, March 1969, pp. 10-11.
6. No-Till Farmer, April 1973, pp. 8-9.
7. "Ten Worst Weeds of Field Crops," (series) Crops and Soils Magazine, December 1969 through November 1970, (Reprints available in lots of 100 or more from:
   Crops and Soils Magazine
   677 South Segoe Rd.
   Madison, Wisconsin 53711
   Cost is $1 per hundred.)
8. Twenty-fifth Illinois Spray Guide, pp. 26, 47.
9. Weed Control--Cultural and Chemical, pp. 9-10, 69, 100-105.

B. Resource personnel
   1. Cooperative Extension specialists
   2. For specific personnel, see VoAg Directory of Resource People in Kentucky.

C. Audio-visuals
   1. Masters
      -1 Use of Herbicides--United States
      -2 Weeds Are Costly
      -3 Wanted: Dead--Reward
      -4 What Kind of Ammo
      -5 Complete Weed Control Program
      -6 Farm Survey for Problem Weeds
      -7 Farm Weed Control Program Plan
      -8 Guide To Selecting the "Best" Herbicide
   2. Slides
      a. "The Wicked World of Weeds"

Use of Herbicides
UNITED STATES



SOURCE: The Ecology of Pesticides

109-4-1

WEEDS ARE COSTLY

SOURCE: Weed Control, Cultural and Chemical, p. 2.

109-4-2

75

WANTED

DEAD

1. Pigweed
2. Crabgrass
3. Lambsquarter
4. Quackgrass
5. Nutweed

6. Johnsongrass
7. Foxtail
8. Canada Thistle
9. Ragweed
10. Barnyardgrass

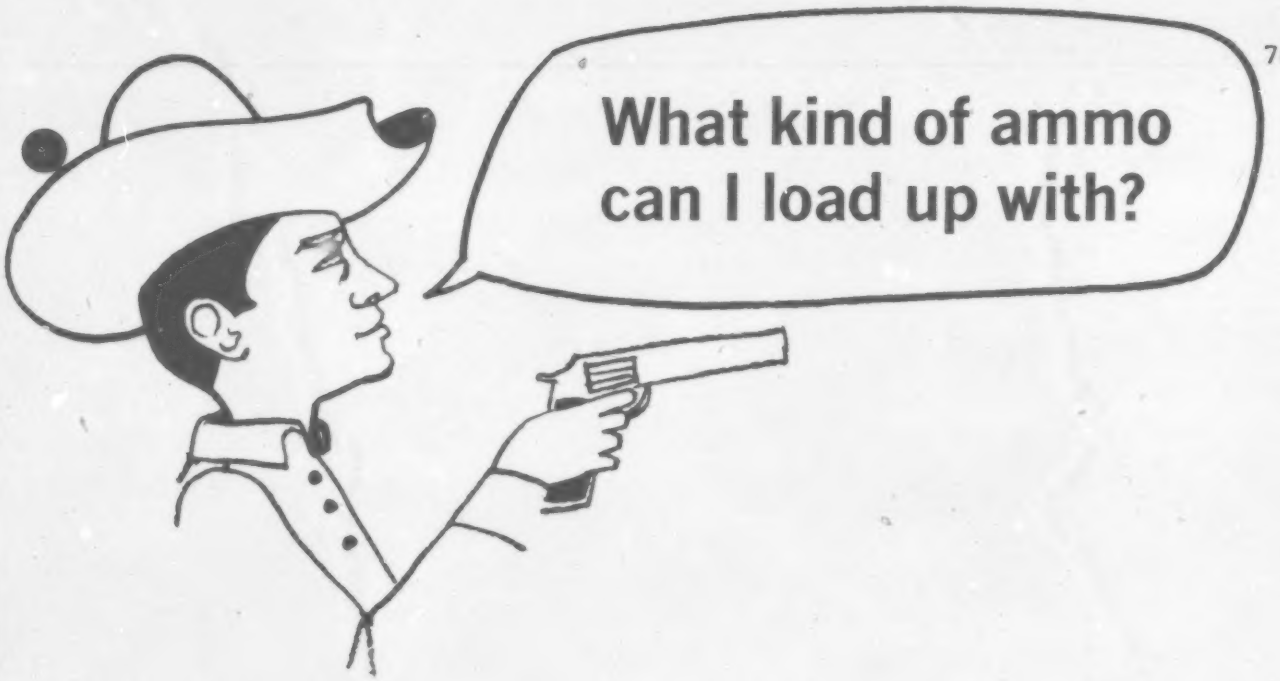
REWARD

(Higher yields, less wear on machinery)

$7,500,000,000

SOURCE: New Holland

109-4-3



	CHEMICAL	or	TRADE NAME
1—	Atrazine		AAtrex
2—			
3—			
4—			
5—			
6—			

SOURCE: New Holland

109-4-4

A COMPLETE WEED CONTROL PROGRAM FOR THE FARM

First

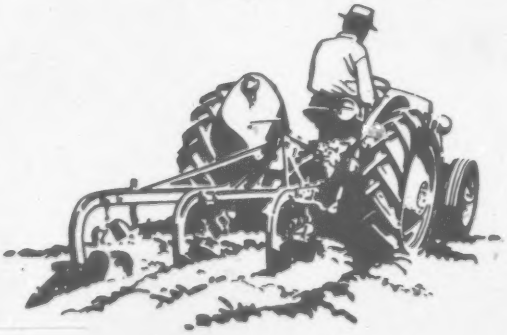
Use high quality seed

Fourth

Use chemical weed killers

Crop Farmers

Chemical salesman and farm advisers should be familiar with weed control programs



Second

Use recommended cultural practices Mechanical and biological

Third

Prevent weeds from forming seeds

SOURCE: Weed Control, Cultural and Chemical, p. 100.

109-4-5

FARM SURVEY OF PROBLEM WEEDS*

(Check each area where weeds are a problem)

Problem Weeds	Tobacco	Corn	Small Grains	Soy-beans	Other Locations								
					Hay Crops		Pasture Crops			Around Build-ings	Yard	Garden	Other
					Leg-umes	Grasses	Leg-umes	Grass	Fence Rows				
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													
9.													
10.													
11.													

* Adapted from Weed Control, Cultural and Chemical, Ohio Ag Ed Service, p. 21.

FARM WEED CONTROL PROGRAM PLAN
(Worksheet)

NAME _____ FARM _____

Crop _____	Crop _____
Major Weed Problem(s) _____	Weed Problem(s) _____
Method(s)* Timing Rate	Method(s) Timing Rate
Crop _____	Crop _____
Weed Problem(s) _____	Weed Problem(s) _____
Method(s) Timing Rate	Method(s) Timing Rate

*(Cultural, Chemical or Biological)

109-4-7

GUIDE TO SELECTING THE "BEST" HERBICIDE

Crop _____

Weed(s) _____

	HERBICIDES		
Method of Application			
Cost per Acre			
Special Equipment Needed			
Crop Tolerance			
Toxicity to Operator			
Danger to Environment			
Other Considerations			

109-4-8

Lesson 5

UTILIZING INSECTICIDES IN THE COMMON ENTERPRISES

Objective -- To develop the effective ability of farmers to properly utilize insecticides in controlling insects of commonly grown crops and livestock.

Problem and Analysis -- How should we use insecticides in controlling insects in our commonly grown crops and livestock?

-Basic insect identification
-Insecticide types -- mode of action
-Insecticide classifications, formulations, residues, and tolerances
-Planning an insect control program for crops and livestock

Content

I. Basic Insect Identification

A. A brief review of insect classification consists of:

1. The first breakdown in classification of the animal kingdom is the phylum. The phylum of which insects are a part is called Arthropoda. This phylum is in turn broken down into five classes with insects being one of the classes. The class is further broken down into orders.
2. The class name given to insects is Insecta or Hexapoda (six legs). All insects during one or more of their life stages, depending on the species, have three pairs of legs.
3. The body of an insect is made up of three parts: the head, the thorax and the abdomen. These parts are most apparent in the adult stage. The eyes, antennae and mouth parts are in the head. The mouth parts, depending upon the species of insect, are

adapted for chewing or sucking.

4. Insecta, or Hexapoda, is the class that is of major economic importance to agricultural production. Of some twenty-four orders of insects, the following ten orders (with insect examples) cause the greater loss of agricultural production: Coleoptera (beetles and weevils); Diptera (flies, mosquitos, gnats); Lepidoptera (butterflies and moths); Hemiptera (the true "bugs" and chinch bugs); Homoptera (aphids, leafhoppers, cicadas, whiteflies, mealybugs, and scale insects); Hymenoptera (bees, wasps, ants); Mallophaga (biting lice); Anoplura (the sucking lice); and Siphonoptera (flies).
5. Another class, Arachnida, order Acarina (ticks and mites), is also of economic importance.

B. Insect life cycle
   1. The life cycle of an insect is from the egg stage to the reproducing adult. The change in shape and appearance during the cycle is known as metamorphosis. There are four different life cycles of insects, they are:
      a. Without metamorphosis
      b. Gradual metamorphosis
      c. Incomplete metamorphosis
      d. Complete metamorphosis
   2. Gradual metamorphosis and complete metamorphosis life cycles seem to more nearly apply to our insects that cause damage. The life cycle of the two are:
      a. Gradual metamorphosis -- the stages include the egg, nymph and the adult.
      b. Complete metamorphosis -- the stages include the egg, larva, pupa and adult.
   3. Insect mouth parts
      a. Insects feed on plants and animals in two ways: chewing and sucking.
         1) Insects with chewing mouth parts obtain their food by biting off parts, e.g. roots, stems, fruit

and foliage.

2) Insects having sucking mouth parts obtain their food from plant sap or blood of animals.

3) Modified types of sucking mouth parts:

a) Rasping-sucking (thrips)

b) Piercing-sucking (aphids, chinch bug, horseflies)

c) Sponging (order Diptera -- flies)

d) Siphoning (moths and butterflies)

b. Many insect control methods are based on:

1) The most vulnerable stage of metamorphosis

2) Type of mouth parts of the insect

II. Insecticide Types and Mode of Action

A. There are three major classifications of insecticides as to mode of action.

1. Stomach insecticides must be swallowed by insects to be effective. Stomach insecticides are effective against insects with chewing mouth parts.

2. Contact insecticides kill insects that touch, swallow, or breathe them. Contact insecticides are effective against insects that have the sucking type mouth, as well as those with chewing mouth parts.

3. Fumigants kill insects in gaseous forms and require a type of enclosure. Fumigants are used in grain and soil fumigation.

B. Systemic insecticides are primarily a stomach insecticide, but a few are also effective as contact insecticides. The principle action of the systemic insecticides is that the materials are absorbed into the plant tissue and the sap of the plant. The systemic insecticides are applied in the soil prior to or at planting time.

C. Many insecticides serve a dual purpose in being used on both plants and animals. Example of

dual purpose insecticide -- Malathion 25 W.P.; label shows use for fruit crops, vegetable crops, alfalfa, and livestock.

III. Insecticide Classification, Formulations, Residues and Tolerances

A. Insecticides or miticides can be classified in several ways:
   1. By their persistence or ability to carry over residually (as residues on crops, in soil and environment)
   2. By their usage as either preventive or corrective measures
   3. By their chemical make-up
   4. By their routes of entry into the target pest

B. Since chemical make-up (refer to A-3 above) is the most often used means of classification, these descriptions and examples are as follows:
   1. Chlorinated hydrocarbons -- Synthetic organic insecticides containing a combined chlorine, especially those with chlorine making up a major proportion (50% or more) of the molecular weight of the compound (now often spoken of as organochlorine insecticides), are Aldrin, Chlordane and DDT (50% Cl). Examples of miticides are Tedion, Kelthane and Ovex.
   2. Organo-phosphorus -- An organic compound containing phosphorous and carbon molecules.
      Non-systemic examples -- Guthion, Diazinon, Ethion, Parathion, Malathion.
      Systemic-type examples -- Di-syston, Systox, Ronnel.
   3. Carbamates -- Carbamate compounds are derived from carbamic acids.
      Non-systemic example -- Sevin.
      Systemic examples -- Furadan, Temik.
   4. Miscellaneous compounds -- Listed in this group are some of the older* insecticides that were among the first used:
      *a. Inorganic metallic -- lead arsenate
      *b. Organic botanicals (plant derived) -- nicotine, Pyrethrum, Rotenone

*c. Inorganic non-metallic -- sodium fluoride
d. Organic carbonate -- Morestan (insecticide, acaricide and fungicide)
e. Organic metallic -- organic tin (Plictron acaricide)
f. Bacterial spores -- Thuricide (Bacillus thuringiensis) insecticide
g. Organics, naturally occurring -- petroleum oils

C. Insecticides and miticides may be grouped by their method of application (formulations). This group and a brief description are:
1. Sprays
a. Wettable powder -- These are dry forms of insecticide or miticide where the chemical ingredient is added to a carrier, such as clay, plus a wetting agent and ground to a powder-like fineness. Wettable powders form a suspension in water when stirred or agitated. Example: Sevin 50 wettable powder.
b. Soluble powders -- As the name indicates, these materials are dry powders that easily dissolve in water. Example: Dylox.
c. Solutions are liquid forms of insecticides or miticides in which the active ingredient is dissolved in a suitable solvent such as petroleum distillates (xylene, toluene). Examples: Thiodan miscible, Ethion-oil mixture.
d. Flowable materials are concentrated pesticides formulated in a paste-like emulsion. These disperse rapidly in water. Examples: Sevin flowable, Furadan 4 flowable.
2. Dusts -- Pesticide dusts are most often made with talcs, pyrophyllite, clays, calcium carbonate, forms of silicates, diatomaceous earth, ground plant materials (tobacco dust, walnut shell) as the diluent materials. Most insecticides can be compounded as

dusts. Example: Sevin 10 dust.

NOTE: At present, dust particle size specifications are usually 10 to 30 microns for ground dusters and 20 to 40 microns for aerial application.

3. Granules -- These are formulated like dusts, but are composed of heavier and larger particles that fall readily upon application. A common range is 15/30, meaning at least 98% by weight will pass through a screen with 15 openings per linear inch, but not more than 5% will pass through a 30 mesh screen. Granular formulations are primarily for soil treatments.
   Examples: Di-syston 15% G.
4. Aerosols -- A system of particles dispersed in a gas. Liquid particles make up a fog. For liquified-gas aerosols, the toxicant is dissolved in a low boiling liquid (Freon 12, methyl chloride), and held under a pressure in a metal cylinder. When a valve is opened, a fine spray is ejected, the propellant liquid is quickly vaporized and the active ingredient remains suspended in the air.
   Example: "bug" bombs.
5. Fumigants -- A substance or mixture of substances which produce gas, vapor, fume, or smoke intended to destroy insects, bacteria or rodents. Used in confined areas such as soil treatment, grain storage, warehouse, etc. Example: Methyl bromide as a soil fumigant.

D. Insecticides and miticides can be grouped according to their route of entry and pest selectivity. (Refer to II A-c above.)

E. Insecticides and miticides are usually applied for one of two principle purposes: (Refer to III A-2 above.)
   1. As a preventive measure -- The chemical is applied on the crop, or soil, before the pest appears in damaging numbers.
   2. As a corrective treatment -- Chemicals that kill most pests present or at least

reduce their number below the economic threshold of damage.
(The economic threshold level of a pest is the level above which economic loss is caused by the pest.)

F. Residues of pesticides -- The long-lived materials are the ones that have us in environmental difficulties today. The term "residue" means that quantity of a substance, especially of active pesticide, remaining on or in a surface or crop (including livestock products). Many degrees of persistency exist, often as a necessary attribute. Example: A contact insecticide must remain on the insect long enough to take effect. Those chlorinated hydrocarbon insecticides such as Dieldrin are much more persistent than organic phosphorous insecticides. Persistency is dependent upon such properties as volatility and resistance to breakdown.

G. Tolerances -- The tolerance for a pesticide is:
1. Under the "Miller Pesticide Residue Amendment" to the Federal Food, Drug and Cosmetic Act, the minute trace permitted by the F.D.A. to be present in or on raw agricultural commodities.
2. Under the "Food Additive Ammendment," the trace permitted in or on processed or semi-processed food or feed products.

NOTE: Follow strictly the cutoff date as recommended on the label or spray guide.

IV. Planning an Insect Control Program Based on Recommendations for Crops and Livestock.

A. Keeping records of insect and mite control, just like a herbicide control program, should be an integral part of record keeping.

B. A grower's insecticide application record will likely be required by law, especially for those growers hiring employees.

C. The insecticide and miticide control program

should include the following features.

1. Select the safest material possible.
2. Select a material that will be effective.
3. Select materials that are not long-lived residuals, when possible.

D. Incorporate in the control program recommendations of the Agricultural Extension Service.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. In usage of pesticides, insecticides follow closely behind that of herbicides.
2. In the lesson on the requirements of a good pest control program, the same requirements apply to the insecticide control program that are stated in the lesson on the requirements of a good pest control program.
3. Greater emphasis needs to be placed on safety, since many of the insecticides are far more toxic than some of the other pesticides.
4. Insect identification is essential from the standpoint of being able to determine whether the insect causing the damage has chewing or sucking mouth parts, and the stage(s) of the life cycle during which the damage is done: larva, adult, etc.
5. The selection of insecticide type as to its mode of action can be a decisive factor in good insect control.
6. The organophosphate insecticides (short-lived residuals) are being used with increasing frequency to replace the more persistent (long-lived residuals) chlorinated hydrocarbon insecticides, such as DDT, DDD, Aldrin, and Endrin. The organophosphates as a group are more toxic and pose a greater potential health hazard to the user. If properly used, they are safe.
7. Planning and keeping records of the insecticide control program is good business.

B. Things to be brought out by class members:

1. What insect pests have given the most trouble in the last year? What areas have they occurred in? Livestock: beef, dairy, hogs, etc.; corn, soybeans, forage crops and tobacco.
2. Successes and/or failures in insect control.

II. Conclusions

A. Insecticide use is important in producing many of the crops and securing good livestock production.

B. To get good insect control, we need to identify the insect pest.

C. It is important to select the right insecticide type to properly control the insect.

D. Select an effective insecticide having the least safety hazard.

E. Select a formulation of insecticide that best fits the need to obtain control of insects.

F. Select insecticides that have the shortest-lived residual effect, yet long enough to get good insect control.

G. Check manufacturer's label or Agricultural Extension Service recommendations for cutoff date to stay within accepted tolerances of residues on the raw agricultural product.

H. Keep grower insecticide records.

III. Enrichment Activities

A. Invite local extension agent or extension specialist in to summarize experimental results of insect control plot work nearest your area.

B. Tour experimental plots (in season).

IV. Suggested Teaching Materials

A. References for Lesson 5

1. Entomology E-Series Publications, E 80; E 81; E 82; E 83; E 84; E 87; E 88; E 89.
2. Crops and Soils, April-May 1973, pp. 4-5.
3. 1973 Pesticide Dictionary

(Kentucky Cooperative Extension Publications:)

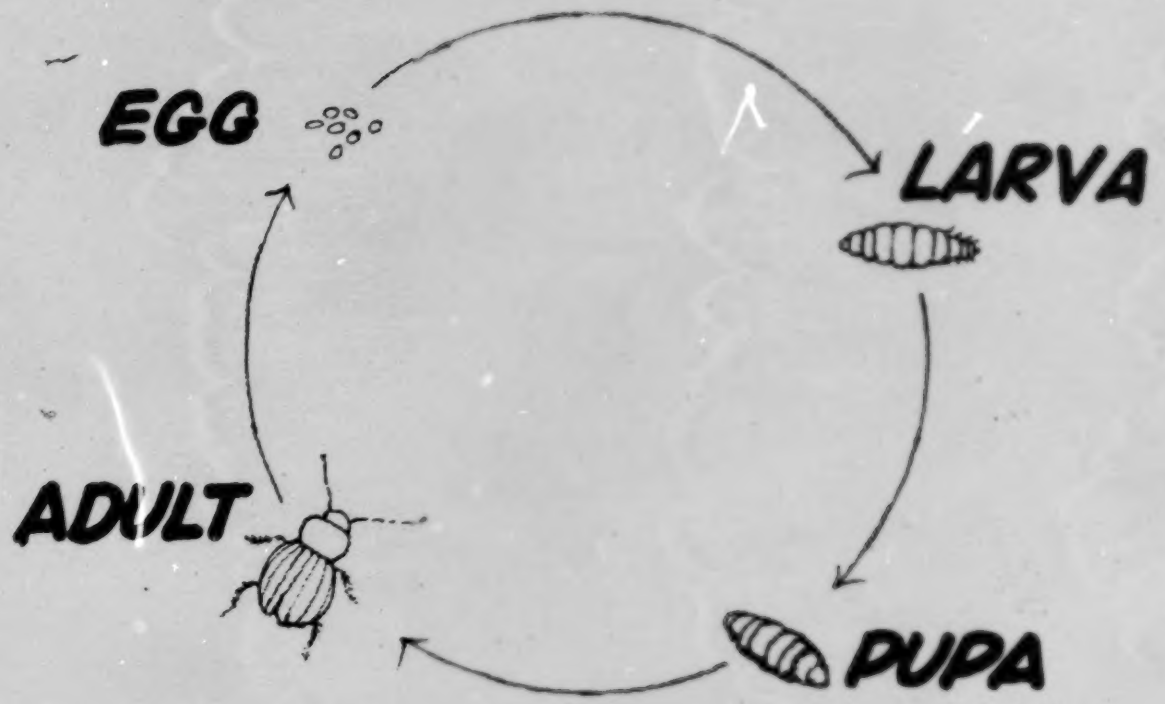
4. Control of Beef Animal Insects, Ent. 11.
5. Insect Control on Lactating Dairy Cows, Ent. 12.
6. Insect Control on Swine, Misc. 261-1.
7. Insect Control on Sheep and Goats, Misc. 362.
8. 1973 Insecticide Recommendations for Alfalfa and Clover, Ent. 17.
9. 1973 Insecticide Recommendations for Field Corn, Small Grains, Grain Sorghum, and Bluegrass, Ent. 16.
10. 1973 Insecticide Recommendations for Tobacco Fields, Ent 15.
11. 1973 Insecticide Recommendations for Tobacco Plant Beds, Ent. 14.
12. 1973 Soybean Insect Control, Ent. 13,

B. For specific personnel, see VoAg Directory of Resource People in Kentucky.

c. Audio-visuals

1. Masters
   - -1 Life Cycle of Insects
   - -2 Grower's Pesticide Application Record
   - -3 Body Parts of Grasshopper
   - -4 Class Member's Chart of Harmful Insects

LIFE CYCLE OF INSECTS



SOURCE: New Holland

109-5-1

GROWER'S PESTICIDE APPLICATION RECORD

Grower's Name

Crop and Variety

DATE OF APPLICATION	NAME OF AREA TREATED (Description)	DATE OF PLANTING OR STAGE OF GROWTH	PESTS CONTROLLED	MATERIALS USED AND HOW APPLIED	AMOUNT MATERIAL USED	AREA COVERED (Acres or Cu. Ft.)	WEATHER CONDITIONS

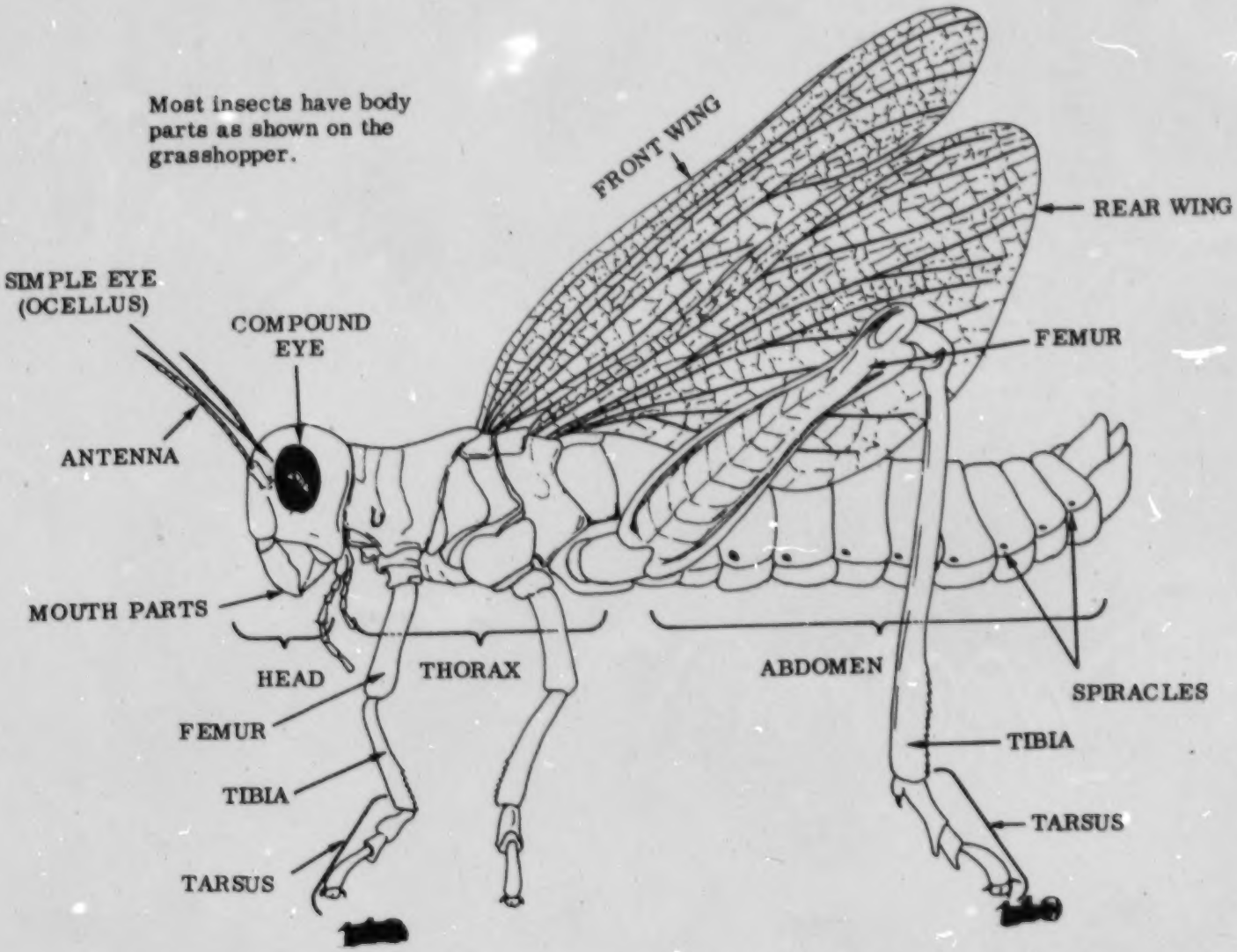
Physician's Phone No.

Use Pesticides Only: —on crop specified, —at time specified —at rate specified

109-5-2

W.O. 1048-20

Most insects have body parts as shown on the grasshopper.



SOURCE: Some Common Types of Insects, Ohio Agricultural Education Service, p. 8.

109-5-3

Class Member's Chart of Harmful Insects

Name of Harmful Insect	Crop or Crops Damaged	Type of Damage	Livestock Attacked	Type of Damage	Prevention or Control

SOURCE: Some Common Types of Insects, Ohio Agricultural Education Service, p. 4.

Lesson 6

UTILIZING FUNGICIDES IN PLANT-DISEASE CONTROL

Objective -- To develop the effective ability of farmers to properly utilize fungicides in plant disease control.

Problem and Analysis -- How should we use fungicides in plant disease control?

-Basic plant-disease identification
-Principles of plant-disease control
-Types of fungicides by general use
-Fungicide classification by chemical group
-Planning a disease-control program

Content

I. Basic Plant Disease Identification

A. The Great Plant Groups -- Three major divisions of the plant kingdom are recognized. These are the Thallophytes, the Bryophytes, and the vascular plants or Tracheophytes. It is mainly the Thallophyte group that we are concerned with here. There are two main series of Thallophytes:

1. The algae possess the green pigment chlorophyll and are able to manufacture their own food; they include all the seaweeds and their fresh water allies. Examples: pond scum, simple green algae of salt and fresh water, brown algae and red algae (almost entirely confined to the sea).
2. The fungi lack chlorophyll and secure their food from living animals, plants, and dead organic materials.
   a. To this group belongs the vast array of bacteria, molds, mildews, blights, rusts, toadstools, mushrooms, and simi-

lar plants. This series of Thallophytes is saprophytic (living on dead organic matter) and/or parasitic (living on or within another living animal or plant).

b. It is the fungi and the fungi-disease producers with which we are mainly concerned in crop disease prevention and control.

c. Fungi reproduce both asexually and sexually.

1) Asexual reproduction may be accomplished either by:

a) The division of an entire unicellular individual into two individuals by fission

b) The formation of unicellular spores

2) Sexual reproduction is accomplished by:

a) The conjugation of similar gametes to form a zygospore (isogamous)

b) The union of dissimilar gametes (male and female) in fertilization to form an oospore (heterogamous)

B. Although no attempt is made here to spell out detailed disease descriptions, the key to preventing loss to plant disease is prompt and correct diagnosis of the problem. Only at this point can proper control measures be applied.

C. In many instances, identifying plant diseases will require the services of a plant pathologist.

D. Where positive plant disease identification is not readily available, the following analysis is suggested as preliminary steps to take:

1. When to suspect disease -- One of the four common symptoms of plant disease would be cause for suspicion of disease involvement:

a. If part of all of the plant starts to die

b. If roots, stems, twig ends, leaves, blossom, fruits, or other plant parts

are abnormal, misshapen, or underdeveloped

c. If the plant fails to respond to fertilizing, watering, insect control, or other recommended practices

d. If the plant or seed starts yielding less or "runs out" after performing well for several years

2. Counterchecks to be sure disease is involved and not symptoms from other causes:

a. Check poor plant adaptation to area.

b. Could the damage have been caused by other means such as insects, pets, or children?

c. Were the plants growing in poorly drained soil, or poor physical soil conditions for root development?

d. Could the damage have been caused by: excessive rainfall, high winds, hail, etc.; mechanical damage due to tillage equipment; or industrial air pollutants?

e. Did the unhealthy plants receive different treatment than the healthy ones?

f. Do different types of plants nearby have the same symptoms? (If so, chances are that plant disease is not involved.)

3. After determining that other symptom-causing conditions are not responsible for the plant's condition, an attempt can be made to personally diagnose the disease through study of the symptoms. If you still cannot identify the trouble, select a specimen and send it to the Extension Plant Pathologist for disease identification. The local Agricultural Extension Agent will forward the specimen, upon request.

II. Principles of Plant Disease Control

A. Definition of plant disease and its features -- Numerous definitions of plant disease exist, although one has been commonly accepted: A plant disease is any condition in which a plant

is different in some way from a normal (i.e., healthy) plant in either structure or function. The four main features of a plant disease are:

1. It is a process.
2. It is physiological.
3. It is abnormal.
4. It is harmful.

B. Causes of plant disease:
   1. The agent causing a plant disease is called a plant pathogen.
   2. Pathogens are divided into two broad groups -- non-parasitic and parasitic.
      a. Non-parasitic diseases are caused by some non-living agent.
      b. Parasitic diseases are caused by living organisms.
      c. Examples of each are:

Non-parasitic Agents	Parasitic Agents	
nutrient deficiency	fungi	plus a susceptible host and a favorable environment
temperature (extremes)	bacteria	
pesticides (excessive)	viruses	
air pollutants	molds	
mechanical damage	rusts	
	nematodes	

C. Developmental stages of disease:
   1. The development of any parasitic disease is critically dependent on the life cycle of the pathogen in association with a susceptible host and a favorable environment before the disease condition can be induced.
   2. Temperature and moisture are probably the most important factors that affect the severity of plant diseases.
   3. The life cycle of a pathogen agent follows these stages:
      a. Inoculation -- Contact between host and pathogen agent
      b. Incubation -- Pathogen agent (inoculum) begins to develop; spore germination, etc.
      c. Infection -- Penetration of plant's surface
      d. Disease development -- When plant

responds to the invasion of the pathogen in some way. Example: Cells die or abnormalities begin to occur.

NOTE: See Master-3, "Typical Disease Cycle" at end of Lesson.

D. Disease identification -- See Basic Plant Disease Identification I.-B,D.

E. Plant disease control -- In most cases plant diseases are controlled by one of the following methods:
   1. The use of disease-resistant varieties
   2. Cultural control (crop management)
   3. Chemical control (mainly fungicides)

III. Types of Fungicides by General Use

Major classifications of fungicides as to mode of action are:

A. Protectant fungicides
   1. These must be applied before the infection occurs to protect the plant from invasion by a pathogen.
   2. Protectant fungicides are probably used in a much larger volume than the other type of fungicides.
   3. Since the development of most diseases is related to the growth of the plant (especially new leaf growth) and to the weather, the protective cover should be kept on the plant from time the leaves start to develop until growth stops.

B. Eradicant fungicides
   1. As the name implies, eradicants are used for the purpose of eliminating an established infection.
   2. These materials generally remain at the point they are applied and do not move in the plant.

C. Systemic fungicides
   1. Systemics can be absorbed by the foliage or other parts of the plant and move within the plant to some degree.

2. Systemic fungicides may act as protectants or eradicants, or both.

D. Fumigant fungicides
1. These are most commonly used to control soil-borne fungi and nematodes.
2. Fumigants are usually applied as a liquid or solid which converts to a gaseous form for dispersement.

NOTE: Always check the label for "Directions for Use" of any of the above.

IV. Fungicide Classification by Chemical Group

A. A chemical group is a grouping together of the chemicals having some common and related chemical base. Example: The carbamate fungicides are derivatives of carbamic acid.

B. These groups are as follows:
1. Antibiotics -- Any of certain chemical substances produced by microorganisms such as bacteria and fungi (molds) and having the capacity to inhibit the growth of or destroy bacteria and certain fungi causing animal and plant disease.
2. Carbamate -- Derivative of carbamic acid
3. Cadmium organic -- Composition contains 60% cadmium succinate (29% metallic bases).
4. Chlorinated benzene -- Chlorine-benzene base
5. Copper fungicide -- This group includes a number of inorganic and organic salts in which copper is the active fungicidal component. Many of these chemicals are called "fixed" coppers.
6. Dicarboximide fungicide
7. Dinitro fungicide -- Derivatives of cresol and phenol
8. Mercury fungicides -- Three groups are derived from this element:
   a. Inorganic salts of mercury
   b. Alkyl mercuries -- Those organic mercury compounds built upon a carbon chain
   c. Phenyl mercuries -- Those organic

mercuries built upon a phenyl ring

9. Quinones fungicides -- Derivatives of chlorine and quinone compounds
10. Sulfure fungicides -- Three groups are derived from this element:
    a. Polysulfide sulfur
    b. Elemental sulfur
    c. Organic sulfur
11. Tin fungicides -- Tin serves as metallic base
12. Soil fumigants -- Chlorinated hydrocarbon group
13. Miscellaneous fungicide group

B. The following is an incomplete list of common names (and brand names) and the chemical group to which they belong (in parentheses):

FUNGICIDES

Common Names - Brand Names

AND GROUP

BOTRAN (CHLORINATED
Botran BENZENES)

CADMIUM (CADMIUM
Caddy ORGANIC)
Cadminate
Vi-Cad

CAPTAN (DICARBOXIMIDE)
Captan
Orthocide 50W

CHLORANIL (QUINONES)
Chloranil
Spergon

DACONIL (CHLORINATED
Daconil BENZENES)
Termil (for fumigation)

DEXON (MISCELLANEOUS)
Dexon

DICHLONE (QUINONES)
Dichlone
Phygon
Phygon XL

DODINE (MISCELLANEOUS)
Cyprex
Dodine

DIFOLATAN (DICARBOXIMIDE)
Difolatan
Folcid

DYRENE (MISCELLANEOUS)
Dyrene

ETHYLENE DIBROMIDE (CHLORINATED HYDROCARBON)
Dowfume MC2

FERBAM (CARBAMATES)
- Coromate
- Ferbam
- Fermate
- Karbam Black
- Niagra Carbamate

FOLPET (DICARBOXIMIDE)
- Folpet
- Ortho Rose & Garden Fungicide
- Phalten

GLYODIN (MISCELLANEOUS)
- Glyodin
- Corona Glyoxide Dry

INORGANIC MERCURIES (INORGANIC SALTS OF MERCURY)
(Mercuric + Mercurous Chloride)
- Calo-Clor
- Calocure
- Calo-Gran
- Doggett Fison Turf Tox
- Fungchex
- Wood Ridge Mixture 21

KARATHANE (DINITRO)
- Karathane
- Mildex

MANEB (CARBAMATES)
- Dithane M-22
- Maneb
- Manzate

M-45 (CARBAMATE)
- Dithane M-45
- Fore

NABAM (CARBAMATES)
- Dithane A-40
- Dithane D-14
- Nabam

PCNB (CHLORINATED BENZENES)
- PCNB
- Terraclor

PHENYL MERCURY (P.M.)
- Coromerc
- Liquiphene Fungicide
- Mersolite 10
- Metasol 10
- Phenmad
- PMA
- PMAS
- Puraturf No. 10
- Quicksan
- SC 110
- Tag Fungicide

POLYRAM (CARBAMATES)
- Polyram

THIRAM (ORGANIC SULFUR)
- Arasan 75
- Spotrete
- Tersan
- Thiram
- Thiramad
- Thylate

ZINEB (CARBAMATES)
- Dithane Z-78
- Parzate
- Zineb

V. Planning a Disease Control Program

A. Fungicides used, like other pesticides, should be kept on record--especially for those raw agricul-

tural products entering the market.

B. Keep a record of fungicide use including such things as: Date of Application, Crop(s) Applied To, Common Name of Fungicide, and Dosage Per Acre.

C. Observe all instructions on the manufacturer's label and recommendations of the Agricultural Extension Service.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:
1. Approximately $16,800,000 was spent on fungicides during the 1971 growing season. This represents a considerable cost to control plant diseases.
2. Disease-causing organisms are so small in size they cannot be seen without magnification. Consequently, inoculation through infection will have occurred before symptoms of disease are apparent. Therefore, to control a given disease, identification has to be established for the disease-causing organisms. Not all diseases can be identified by symptoms but require the work of a plant pathologist.
3. For the control of most economic diseases a protectant-type fungicide will be most effective.
4. The fungicides used for controlling plant diseases are many and varied, and categorized in several ways.
5. Fungicides have been used in fruit and vegetable production for many years. More recently fungicides are occasionally used on general crops.
6. Recent studies on small grain and alfalfa are bringing to light the losses incurred because diseases are not controlled. Therefore, a likely increased usage of fungicides is seen in the future.

B. Things to be brought out by the class members:
1. Specific uses of fungicides by class mem-

bers on various crops grown.
2. Problems of disease identification.
3. The degree of control of diseases achieved.

II. Conclusion

A. It is important to know whether the disease is fungus-related, nutritional or environmental.

B. Fungi-causing organisms have life cycles. With the use of fungicides the life cycle can be interrupted or controlled.

C. Fungicides are used as protectants, eradicants and systemics.

D. Fungicides are classified by chemical group with chemical name, common name and trade or proprietary name.

E. Every grower should keep records of fungicides used on crops.

F. Follow manufacture's label or Agricultural Extension Service recommendations for use of fungicides.

III. Enrichment Activities

A. Plan a field trip in your area where a commercial orchard or vegetables are grown for the market.

B. Have a grower recap the <u>importance</u> of weed control, insect control and disease control.

C. Invite Extension Specialist in plant pathology from the University of Kentucky to speak to the group.

IV. Suggested Teaching Materials

A. References for Lesson 6
1. <u>Botany Principles and Problems</u>, pp. 22-23; 497-541.
2. <u>Chemical Control of Plant Disease</u>, pp. 31-43.

3. Guide for Chemical Control of Vegetable Diseases, pp. 2-11.
4. Home Garden Vegetable Disease Control, pp. A-4.
5. Tobacco Diseases, Cir. 522-A, p. 14.
6. "The Worst Diseases of Crops" (Series) Crops and Soils Magazine, March 1972-January 1973, (Reprints available in lots of 100 from Crops and Soils Magazine, 677 South Segoe Road, Madison, Wisconsin, 53711. Cost $1).

B. For specific personnel, See VoAg Directory of Resource People in Kentucky.

C. Audio-visuals

1. Masters

-1	Record Sheet for Fungicide Users
-2	Contents of an Acre of Soil
-3	Typical Disease Cycle
-4	Names Derived from Plant Parts Affected
-5	When to Suspect Disease
-6	How to be Sure Disease is Involved
-7A-D	How and Where to Get a Diagnosis
-8A-D	Selecting Specimens to Have Diagnosed
-9A-C	How to Send Specimens
-10	Where and When to Send Specimens
-11A-D	Terms Used in Plant Disease Identification
-12A,B	Worst Diseases of Crops

RECORD SHEET FOR FUNGICIDE USERS

Date	Crop(s)	Chemical	Dosage per acre	Remarks

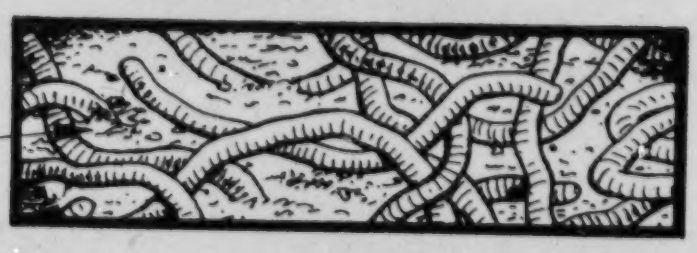
109-6-1

AN ACRE OF AVERAGE SOIL, SEVEN INCHES IN DEPTH, MAY CONTAIN:

- 500 LBS. OF BACTERIA
- 1,000 - 1,500 LBS. OF FUNGI
- 700 LBS. OF ACTINOMYCES
- 200-300 LBS. OF PROTOZOA
- LARGE AMOUNTS OF NEMATODES And ALGAE

PLUS....

- 200 - 1000 LBS. OF EARTHWORMS



T. VANTREESE, INST MATL LAB, U.K.

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109-6-2

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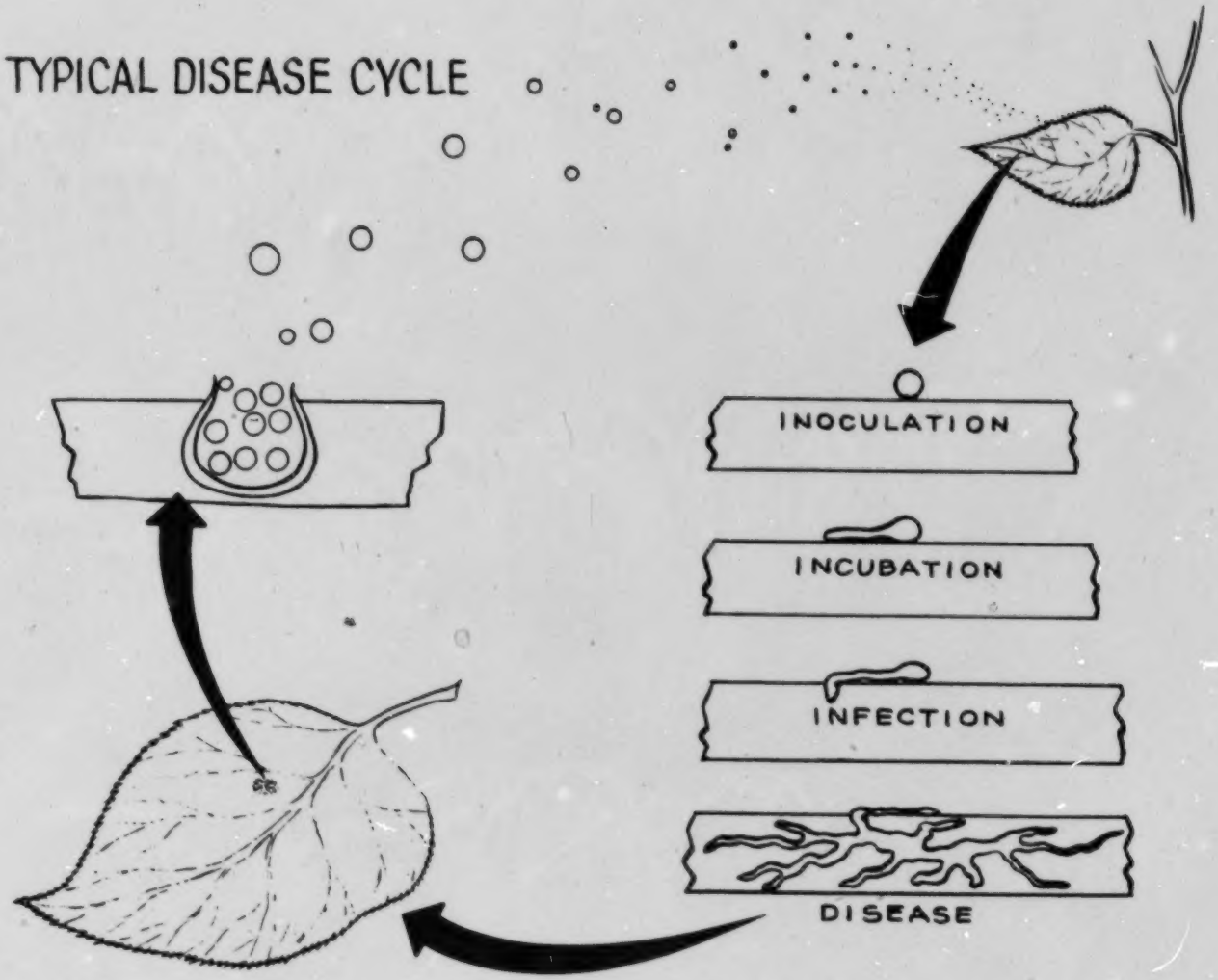
TYPICAL DISEASE CYCLE

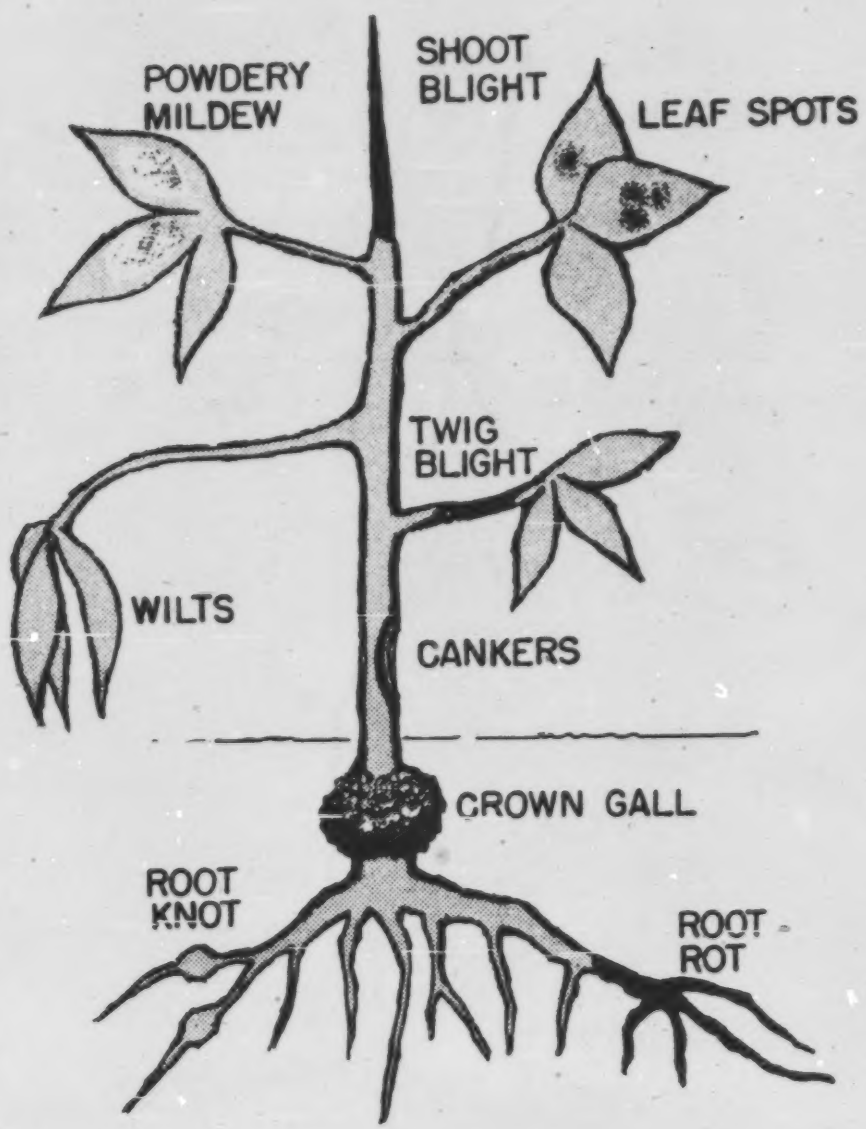


SOURCE: Washington State Pest Control Handbook

109-6-3

PLANT DISEASES:

NAMES DERIVED FROM PARTS AFFECTED



SOURCE: Washington State Pest Control Handbook,, p. 426 109-6-4

W.O. 1048-72

WHEN TO SUSPECT DISEASE

You Can Suspect Disease If:

1. Part or all of plant starts to die.
2. Plant parts are abnormal, misshapen or underdeveloped.
3. Plant fails to respond to fertilizing, watering, insect control, etc.
4. Plant or seed starts yielding less after several good years.

SOURCE: Texas Agricultural Extension, Publication MP-512.

i09-6-5

HOW TO BE SURE DISEASE IS INVOLVED

Other conditions besides disease can cause the symptoms just mentioned. Before getting damaged plants diagnosed, check to see if the trouble might have been caused by something else.

1. Were the affected plants suited to the area? Exotic plants, such as citrus trees, banana plants, palm trees, etc., selected at random from nursery catalogs may get sick because they are not suited to Kentucky conditions.

2. Could the damage have been caused by insects, pets, children?

3. Were the plants growing in poorly drained soil; gravel; over construction debris like boards, cement blocks, bricks, old driveways; or in other unfavorable environments?

4. Could the damage have been caused by high winds, hail, driving rain, blowing sand; or mechanically by garden tools and power equipment; or by fumes from trash burners or industrial plants?

5. Did the unhealthy plants receive different treatment than the healthy ones, such as watering, pruning, fertilizing, chemical pest control?

6. Do different types of plants nearby have the same symptoms? If so, chances are that plant disease is not involved.

SOURCE: Texas Agricultural Extension, Publication MP-512.

109-6-6

HOW AND WHERE TO GET A DIAGNOSIS

STEP I: Examine all parts of the plant, especially the roots. Look for abnormal root growth by comparing them with healthy plant roots.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-7A

W.O. 1048-23

HOW AND WHERE TO GET A DIAGNOSIS

STEP 2: Check to see if nearby plants are affected.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-7B

W.O. 1048-25

HOW AND WHERE TO GET A DIAGNOSIS

STEP 3: Then contact your county Extension agent's office for publications on plant disease. Chances are the agent himself will be able to help you identify the problem. (Check the phone book for your local Extension office.)

SOURCE: Texas Agricultural Extension Publication, MP-512.

HOW AND WHERE TO GET A DIAGNOSIS

STEP 4: Read the available publications to see if the descriptions mentioned compare with yours.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-7D

SELECTING SPECIMENS TO HAVE DIAGNOSED

STEP I: If you still can't identify the trouble select a specimen to send to the extension plant pathologists at the University of Kentucky.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-8A

SELECTING SPECIMENS TO HAVE DIAGNOSED

STEP 2: Don't be afraid to send in large specimens. Small ones often fail to show a suffient range of symptons to make accurate identification possible. If you plan to send in a complete plant, select one that is partly alive.

If leaf, stem or fruit spots appear on above-ground plant parts, send only the parts showing the spots or lesions and a sample of similar but unaffected parts. Rots on fleshy fruits and vegetables need special attention. Select fresh specimens with young symptoms, not old ones in advanced stages of decay. These are useless for disease identification. (They smell badly too.)

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-8B

No. 1049-29

SELECTING SPECIMENS TO HAVE DIAGNOSED

STEP 3: Dig the plant -- don't pull it.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-8C

WO. 1048-29

SELECTING SPECIMENS TO HAVE DIAGNOSED

STEP 4: Wash the soil from the roots, and allow a few minutes for drying. In some cases, it's not necessary or possible to send complete plants for diagnosis. For instance --

If cankers appear on shrubs or trees, select canker or twig specimens from recent infections. Send entire cankered portion containing some healthy wood beyond the canker. If cankers occur on large limbs or trunks, send just the cankered section. Branches and twigs that have been dead for several months are useless for identification.

If yellowing or wilting is found on the foliage, root trouble is often the reason. Include the crown of the plant as well as part of the root system. Do not send soil samples.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-8D

W.O. 1049-30

HOW TO SEND SPECIMENS

STEP I: Entire plants or roots should be placed in polyethylene bags (freezer bags) and tied securely. Or wrap them in paper with moist towels or cotton around the roots, then cover with heavy wrapping paper.

Fruit specimens should also be placed individually in freezer bags or can be wrapped separately in wax paper. Don't pack in wet towels or cotton. Moisture only hastens decay.

Green leaves should be pressed flat and put between two filing cards or pieces of cardboard secured with rubber bands.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-9A

WO. 1048-33

HOW TO SEND SPECIMENS

STEP 2: Then fill out a sheet or form including all pertinent information on the problem. Be sure to name the plant. It's difficult to diagnose disease on "a leaf from my flower bed" or "a twig from a shrub in my back yard." Also check the "Terms Used in Plant Disease Identification" when describing the disease symptoms.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-9B

HOW TO SEND SPECIMENS

STEP 3: Finally, place the specimen and identification form in a sturdy container--carton, box, mailing tube. Pack the container lightly to prevent the specimen from becoming further damaged in shipping.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-9C

Where and When to Send Specimens

Secure a Plant Disease ID Form from your county extension agent, then mail specimens and the form to:

Plant Disease Diagnostic Laboratory
Department of Plant Pathology
Agricultural Science Center
University of Kentucky
Lexington, Kentucky 40506

Mail specimens so they arrive early in the week. Those that lie in the mail over the weekend often spoil.

The pathologist's diagnosis and control recommendations will be sent to you, the county agent, and (if specified) the Vo Ag teacher.

SOURCE: Texas Agricultural Extension Publication, MP-512.

109-6-10

TERMS USED IN PLANT DISEASE IDENTIFICATION

The symptoms of plant disease are the clues to accurate diagnosis. Therefore, it's important that the terms used to describe the symptoms mean the same thing to you as they do to pathologist. The following are common terms in describing disease symptoms:

BLIGHT

Rapid discoloration and death of tissues over certain parts of the plant. Used as a general way to describe a disease condition which may include spotting, sudden wilting or death of leaves, stems, flowers, or entire plants. Usually coupled with the name of the plant part affected, like twig blight, blossom blight, tip blight, cane blight, leaf blight, etc.

BURN

A condition in which the cells of the plant become reddish or dark-brown and collapse.

CANKER

A definite dead area, usually on woody stems, surrounded by live tissue.

CHLOROSIS:

Yellowing of normally green tissues. Many diseases cause chlorosis, and often the pattern of the chlorotic area helps to diagnose the disease.

CURL

A puff-like distortion of a leaf resulting from the unequal development of its top and lower surfaces.

DAMPING-OFF

A disease of young seedlings caused by soil-borne fungi. Infected seedlings topple over and die just after they emerge from the soil. In some cases, seedlings may "damp-off" before they emerge from the soil.

DWARFING

The underdevelopment of any organ of the plant or the entire plant.

ETIOLATED

Yellowed because of shading or disturbed nutrition.

EXUDATE

Any substance formed inside a plant and discharged through a natural opening or wound.

FLAGGING

Loss of rigidity and drooping of plant parts, usually because of water deficiency.

GALL

A pronounced localized swelling or outgrowth, often more or less spherical and composed of disorganized cells.

HAIRY ROOT

Development of an abnormally large number of small roots in a small area of the root.

HOST

The plant which is invaded or parasitized by a disease producing agency. The "host range" refers to the various kinds of plants that are affected by a specific parasite.

KNOT

A knob-like growth on roots or stems.

LESION

A localized spot of diseased tissue. Spots, cankers, blisters, scabs, etc. are lesions.

MOLD

Any fungus that produces a superficial, often woolly growth, on various types of organic matter or on plant parts.

MOSAIC

Disarrangement of the chlorophyll content of plant tissue, especially leaves, resulting in dark green and light green, or yellow areas forming a variegated pattern. Typical symptom of some virus diseases.

MUMMY

A dried, shrivelled fruit, the result of some fungus diseases, such as brown rot of stone fruits.

NECROSIS

The death or disintegration of cells and tissues.

PATHOGEN

An organism capable of causing a plant disease.

PROLIFERATION

Abnormal bush-like outgrowths.

PUSTULE

A pimple-like or blister-like growth on a plant surface caused by infection with a pathogen.

RHIZOMORPHS

String-like strand of fungus hyphae.

ROT

A state of putrefaction or decomposition.

SCAB

The abnormal thickening of the outer layer or layers of tissue resulting from local irritation.

SCORCH

Burning of tissues.

SHOTHOLING

A disease symptom in which small roundish fragments drop out of leaves giving them the appearance of having been riddled by shot.

SPORE

Pertaining to fungi, it is a propagative unit that may be considered analogous to the seed of green plants.

VECTOR

An agent that may carry or transmit the cause of a plant disease.

VIRULIFEROUS

Capable of transmitting a virus.

WILT

Loss of rigidity and drooping of plant parts. Similar to flagging except a wilt usually involves a greater portion of the plant.

WITCHES BROOM

A broom-like growth produced by the dense clustering of branches.

YELLOWING

Loss of green color due to degeneration or disorganization of chlorophyll or chloroplasts. Comparable to chlorosis.

SOURCE: Texas Agricultural Extension Publication, MP-512.

WORST DISEASES OF CROPS

Corn
- Root and stalk rots (Pythium, Diplodia, Gibberella, Sclerotium, Fusarium)
- Leaf Blights (Helminthosporium, Phyllosticta)
- Maize Dwarf Mosaic

Soybeans
- Brown stem rot
- Bacterial blight
- Bud blight
- Phytophthora rot
- Bacterial pustule
- Root-knot

Oats
- Oat leaf rust (crown)
- Stem rust
- Yellow Dwarf (Red Leaf)
- Oat Mosaic
- Septoria blight (Dark Stem)
- Blast
- Root rot
- Smut
- Helminthosporium leaf
- Halo blight

Barley
- Leaf rust
- Stem rust
- Yellow dwarf
- Barley stripe mosaic
- Spot blotch
- Net blotch
- Septoria leaf blotch
- Stripe
- Scab
- Smut
- Bacterial blight
- Powdering mildew
- Scald

Wheat
- Rusts (stem rust, leaf rust, and stripe rust)
- Stinking Smut
- Virus diseases (streak mosaic, yellow dwarf, and soilborne mosaic)
- Septoria
- Root rot
- Foot rot

109-6-12A

Alfalfa
- Bacteria wilt
- Phytophthora root rot
- Common leaf spot
- Spring blackstem
- Anthracnose
- Crown rot

Turfgrass
- Brown patch
- Dollar spot
- Fusarium blight
- Fairy rings
- Pythium blights
- Pink snow mold (Fusarium)
- Grey snow mold
- Helminthosporium
- Leaf spot
- Crown rot

SOURCE: Crops and Soils Magazine, February, 1972 to March, 1973.

109-6-12B

Lesson 7

UTILIZING MISCELLANEOUS PESTICIDES

Objective -- To develop the effective ability to utilize miscellaneous pesticides in controlling the less-common pests.

Problem and Analysis -- How should we use the miscellaneous pesticides for controlling less-common pests on the farm?

-Rodenticides
-Acaricides (miticides)
-Avicides
-Nematocides

Content

I. Rodenticides

A. Definitions
1. The Winston Dictionary defines rodent as:
a. Gnawing; biting
b. Like a gnawing animal
c. Pertaining to an order (Rodentia) of gnawing mammals having strong incisor teeth, including the rats, mice, squirrels, beavers, groundhogs, and the like.
2. The term rodenticide as spelled out in the provisions of the Federal Insecticide, Fungicide and Rodenticide Act, "means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating rodents or any other vertebrate animal which the Secretary shall declare to be a pest."

B. Rodents cause great losses in the following ways:
1. Loss of food -- Earlier estimates on rats

alone showed a rat population of 100 million which cost Americans over $1 billion each year. This $10 loss per rat breaks down to $3 for the 40 pounds of food he eats, $6 for other food he contaminates, and another $1 for damaged property.

2. Diseases -- Diseases borne by rats and other rodents are many. No dollar value can be fixed on the misery and death caused each year by rat-borne diseases.
3. Property loss -- Property loss due to rats is accounted for in the following ways:
   a. Damage to electrical wire insulation, causing electrical short circuits to start fires.
   b. Damage to other electrical equipment systems. Example: Communication systems.
   c. Rat burrows undermine and weaken building foundations and embankments for water-holding purposes.

C. Principles of rodent control -- While the following mainly concerns the rodents, rats and mice, it only seems logical that similar applications can be made to other rodents.
   1. The activities of rats and mice are influenced by "drives." Maternal drives, hunger drives, sex drives and curiosity drives are often considered the major factors influencing rats. A basic knowledge of the habits associated with these drives aids in applying the existing methods of control more successfully.
      a. Food and water -- Rats usually start their search for food and water after sunset each day. In the case of hunger, their efforts to find something to eat increases for 3 to 4 days, after which activity decreases at the onset of weakness. The thirst drive is similar, but occurs more rapidly. Efforts to quench their thirst reach a peak in 24 to 48 hours -- followed by weakness and rapid decline of effort. This necessity of food and water provides a prime means of rat control by good sanitation and rat rodenticides.

b. Nesting and harborage areas will be selected that offer the most security in relation to nearest potential food and water supplies.
c. Burrowing -- The Norway rat is predominately a burrower and builds many tunnels and numerous exits. In using fumigation type control these exits will need to be located and filled or stopped-up.
d. Migration -- Migrations may be classified as non-recurring and seasonal migration. Non-recurring are presumably caused by crop failures, floods, etc. Seasonal migration occurs quite frequently on farms, from buildings and storage areas to fields in warm weather and return during cold weather.

2. The following fundamental principles should be kept in mind in undertaking control measures:
   a. The number of rats in any given area is directly proportional to the amount of food and harborage available.
   b. Rats live in a highly competitive environment and any reduction of food and harborage increases this competition.
   c. An increase of competition by the manipulation of the rats' environment will result in a decrease of the rat population.

D. The following procedures would be applicable for a control program on individual farms, as well as, in a community control program:
   1. A well-planned and executed sanitation program is essential for effective results.
   2. Proper sanitation consists chiefly of adequate refuse storage, collection and disposal practices.
   3. Timing of rodenticide application is of prime importance. The application of rodenticides must precede any clean-up of refuse, removal of harborage and ratproofing.

E. Types of rodenticides and characteristics

1. Anticoaqulants: Anticoaqulants have proven to be outstanding in their value to the general public. Warfarin, which was the first of this group to be developed, belongs, along with fumarin, to the group of chemicals known as hydroxycoumarins. Pival, diphacinone, and PMP, developed in that order, are indandiones. Both types of chemicals prevent the blood from clotting, hence the term anticoagulants. These chemicals must be taken daily over a period of several days, a radically different approach to control than that of single-dose poisons. Rodents, apparently not associating the cumulative effect of internal hemorrhaging with their food supply, return to feed on treated baits again and again. Thus the common problem of bait shyness is not encountered when using anticoagulants. At the same time, hazards to other animals from single accidental feedings are greatly reduced. Since repeated feedings are required, permanent covered bait stations provide an excellent method of exposure. Use of relatively large quantities of bait eleminates the necessity for daily care. Anticoagulants possess the added advantages of being effective against both rats and mice.
2. Zinc Phosphide: Of the single-dose poisons mentioned above, zinc phophide is the most satisfactory material. It is not widely used because it is not as readily available as are other materials. The offensive odor and unattractive color provide a safety factor. Most domestic animals will not eat baits prepared with it, but rodents seem to like the pungent odar of phosphorus compounds. Furthermore, all species of rats and mice readily accept zinc phosphide-treated baits. Of the single-dose poisons mentioned, it is the most likely to produce universally satisfactory results.
3. Red Squill and ANTU: Red squill is one of

the best known and least hazardous poisons for the untrained individual to handle. Its natural emetic factor offers protection to animals capable of vomiting. However, since some farm animals do not vomit, care must be taken to prevent their contact with the material. There are two major shortcomings to red squill: it is relatively distasteful and it is quite mild. So much squill must be included in the bait that some rats object to the taste and soon learn to refuse it. Commercial production has been virtually discontinued in recent years due to the poor quality of material offered for import, requiring expensive reprocessing. It is generally ineffective against house mice. ANTU, if used properly, will give good results against Norway rats, but is ineffective against roof rats and is of no value against house mice. The strong reluctance of rats to accept a second dose and the marked tolerance which develops limits the usefulness of ANTU. It should not be used more often than at six month intervals to obtain best results. Baits containing the material should not be left in place for more than three or four days.

4. Miscellaneous: Commercial preparations of prepared baits containing arsenic, phosphorus, and strychnine are commonly sold on the retail market; their use is best restricted to indoor protected stations where accidental poisoning hazards are minimized. Barium carbonate, once rather widely recommended, is no longer used as it is too weak to be effective. Thallium sulfate is dangerous and quite costly; except for some baits used for mouse, mole, and ground squirrel control, it is used almost exclusively by professional operators. Sodium fluoroacetate, or Compound 1080, is not available to the general public because of its extreme toxicity. (See Master-3 at end of lesson for comparison of common rodenticides.)

SOURCE: Wildlife Leaflet 336.

F. Planning the control program -- The type of rodenticide to use in the planned control program depends largely upon safety conditions with respect to humans, livestock, and pets.

II. Acaricides (miticides)

A. Review of mite classification
1. Mites belong to the order Arachnida.
2. Mites and ticks belong to the class Acarina (hence the term acaricide). The only difference between mites and ticks is a difference in size; the latter are much larger in size.
3. Differentiation of mites and ticks from spiders or insects can usually be made at a glance because the mite body consists of two regions. Also, mites differ from insects in having four pairs of legs and in having no antennae, true jaws or compound eyes. A curous feature is that newly hatched young have only three pair of legs, but acquire the fourth pair later in maturity.
4. The life cycle, or metamorphosis, is more nearly akin to no metamorphosis (egg-young-adult).
5. Mites have sucking mouthparts and feed by drawing out plant juices. They may appear at any time during the growing season, but are most destructive during hot, dry weather.
6. There are several species of mites which are most commonly identified by common names such as European Red mite, Two-spotted or "Spider" mite, Spruce mite, Pear Rust mite, Clover mite, Almond mite and others.

B. The economic importance of mite control can be easily understood by way of comparison; lack of mite control could mean the difference between success or failure for many growers, including: fruit growers, vegetable growers, ornamental horticulturists and greenhouse operators.

C. Miticide types and modes of action:
1. Contact (See Lesson 5, II A-2.)
2. Systemic (See Lesson 5, II A-3.)

D. Miticide classifications:

1. Chlorinated hydrocarbons -- Example: Ovex, Kelthane, Tedion, Thiodon, Acaralate
2. Organo-phosphates: Ethion, Malathion, Phosdrin Chlorobenzilate, TEPP, Phosphamidon, Trithion
3. Carbamates: Morestan, Morocide
4. Miscellaneous compounds:
   a. Organic-naturally occurring: oils
   b. Organic metallic: Plictron

NOTE: The above underlined miticides are referred to as specific miticides and used as miticides only (not a complete listing); the others listed are broad-spectrum insecticides having miticidal value.

E. Formulation of miticides as to method of application:
   1. Sprays -- wettable powders (wp), emulsifiable concentrate
   2. Dusts (See Lesson 5 III C.)

F. Residues and tolerances for miticides have the same significance as for insectidides. Always follow the label or spray guide recommendations.

G. Farmers should plan a mite-control program when planning their insecticide-control program.
   1. Because a crop requires insecticide control does not necessarily mean that a miticide is required for that particular crop.
   2. Effective mite control depends on good spray or dust coverage, proper gallonage, and full-strength dosage. Do not rely on a single application for mite control.

III. Avicides

A. Avicides are substances used to control pest birds. Generally they are not designed to kill, but only to pepel or to so affect a few individuals that others are frightened away.

B. Some common pest birds are: pigeons, starlings, English sparrows, and blackbirds. (See pictorial key to some common pest birds of importance to public health, Master-5, at end of lesson.)

C. The following are examples of avicides:

Blackbirds	English sparrows and pigeons
Aldrin plus hardwood oil	Avitrol
Avitrol	Endrin
	Fenthion
	Strychnine and strychnine sulfate

Crows	Starlings
Aldrin plus hardwood oil	Avitrol
Avitrol	DRC 1339
Coal tar products	Fenthion
Cupric oxalate	Polyethylene, Polybutene
Dieldrin plus cupric oxalate	Sodium fluoride

NOTE: These are for illustrative purposes only.

D. To properly utilize avicides:
1. Comply with state and federal legal requirements.
2. Contact proper officials for recommendations and assistance.
3. Some avicides are for professional use only and are not for sale to the public.
4. Some avicides require federal and state permits.

IV. Nematocides

A. Economic importance
1. Nematodes have considerable importance as injurious parasites of plants, animals, and man. It is the parasitic nematodes on which we want to focus our attention.
2. Nematode damage to cultivated crops in the United States has been conservatively estimated at one-half billion dollars, not to mention dollar losses accruing to livestock and man.

B. Review of nematode classification
1. Nematodes belong to the phylum Nemathelminthes; class Nematoda; order Nematode; family Nematodiae; many genera and thousands of species exist.
2. Members of the phylum Nemathelminthes ("Nematos" is thread; "helminthes" are worms) are called roundworms or threadworms.

C. Description of nematodes
   1. They are cyclindrical unsegmented worms, possessing a digestive tube with both mouth and anus and a body cavity.
   2. Many nematodes are free-living and many are parasitic; the great majority are parasitic.
   3. Nematodes range in length up to thirteen inches or more (those parasitic to animal and man) and one sixty-fourth to one-quarter of an inch for plant-parasitic nematodes. Most kinds can only be seen through a microscope.

D. Nematode identification
   1. Since nematodes are usually too small to see, the only way to detect their presence is to have plant specimens and/or soil examined by a plant nematologist or to depend on your own ability to recognize damage symptoms.
   2. Nematode symptoms are often like those characteristics of any sick or unhealthy plant due to insects, disease, nutritional deficiencies, moisture conditions and other typical injuries.
   3. To determine if nematodes are present:
      a. First examine the soil or plants to eliminate likely causes mentioned.
      b. After examination and failure to positively identify nematodes present, but if nematodes are still suspected, take a soil sample and/or plant material to your county extension agent to forward the sample to a plant pathologist.

E. Plant-parasitic nematodes can generally be classified based on some particular characteristic or habit:
   1. Cyst formers -- Soybean cyst nematode
   2. Root-penetrating nematodes (endoparasitic) -- Potato rot nematode
   3. Root-knot nematodes -- Barley root-knot nematode
   4. Root-lesion or meadow nematode -- Corn nematode

5. Nematodes that feed on root surfaces (ecto-parasitic) -- Example: Stylet nematode.

F. Nematode control. Nematodes may be controlled by:

1. Cultural practices presently appear to be the most economical way of controlling nematodes on low-value crops.
   a. Crop rotation, resistant plant varieties, and sanitation practices are essential for maintaining control by cultural practices.
   b. Cultural practices work best against species which have a limited number of hosts.
2. Nematocide treatment
   a. Nematocides control a wide range of soil nematodes and are practical for high-value crops such as vegetables and flowers. Depending upon the material used, rate per acre, and method of application, soil fumigation costs approximately $40 to $80 per acre.
   b. Overall soil fumigation of an entire field (broadcast) can be done in one of five ways:
      1) Plow application. Plow applicators deliver the fumigant into the furrow as the soil is turned (requires immediate sealing).
      2) Tooth or chisel application. These applicators are attached to the tractor mounted cultivators; the chisels or teeth are spaced 10 to 12 inches apart. The chisels place the fumigant 6 to 8 inches in the soil by means of tubes attached to the chisel (requires sealing).
      3) Row treatment. In row treatment, the fumigant is applied only to the narrow strip where the crop is to be grown.
      4) Irrigation application. Fumigant is metered into irrigation water.

5) Side-dressing established plants. The fumigant is injected on both sides of the row with power equipment. (Caution -- Check for plant tolerance listing.)

G. Nematocide examples and formulations (listed by common name):
   1. Chloropicrin (liquid)
   2. D-D (liquid)
   3. Ethylene dibromide (liquid)
   4. Methyl bromide (liquid)
   5. Mylone (dust)
   6. DBCP (Nemagon) emulsifiable concentrate (solution/granules)
   7. Vorlex (liquid)
   8. Telone (liquid)

H. Planning a nematocide control program.
   1. Where nematodes are known to be a problem for a specific crop, a control program should be applied using cultural methods or nematocide control, depending on the range of crop value.
   2. In using nematocide control, combining of the cultural practices, in addition to use of nematocides, would strengthen the overall program.
   3. Keep records on fields or areas treated and fields under suspicion.
   4. Until sufficient experience has been gained, secure the help and recommendations of a nematologist.

Suggestions for Teaching the Lesson

I. Developing the Situation
   A. Things to be brought out by the teacher:
      1. The pesticides falling under the category of "miscellaneous pesticides" should not be misconstrued as being unimportant. In fact, taken individually and where the need exists, they are just as important as any pesticide discussed.
      2. It is granted however, that volume-wise, these pesticides are not sold in quantity like herbicides, insecticides and fungicides.
      3. Rodenticides have a place in the pest control

of most farms. Few if any farms are immune from rodents.

4. For commercial vegetable growers, ornamental, greenhouse producers and fruit growers, miticides are an important link in pest control.
5. The use of avicides for pest bird control may be essential in many different types of farm operations. Here, we are dealing with a public relations-type situation in pest control and should follow federal, state and county guidelines strictly.
6. Many farmers today are following continuous cropping programs (omitting crop rotations), this type of program does not encourage ematode control. In some areas of specialized crop production, the use of nematocides is already essential.

B. Things to be brought out by members of the class:
   1. Experiences in maintaining good rodent control.
   2. Existing needs if any, for mite control and experiences in maintaining mite control where its use is required.
   3. Experiences in pest bird control.
   4. Existing needs, if any, for nematode control and experiences of these that have used nematocides.

II. Conclusions:

A. By proper sanitation and supplementary use of rodenticides, a good rodent control program can be maintained.

B. Miticide use is important in producing many specialized crops.

C. It is important to select materials that are known to have miticidal value. (Not all insecticides are miticides.)

D. In using avicides for pest bird control, base your decision on the economic standpoint.

E. Some avicides require a permit for use.

F. Check with the proper federal, state or county officials for recommendations for pest bird control measures.

G. For low-value crops, nematodes can more economically be controlled by using cultural practices; sanitation, resistant varieties, and crop rotations.

H. For high-value crops the use of nematocides is practical and feasible.

I. Keep grower records when using rodenticides, miticides, avicides, and nematocides.

III. Enrichment Activities

A. Take a field trip to a place where a successful program is being carried out using any one of the miscellaneous pesticides.

B. Invite local Entension Agent or Entension Plant Pathologist to demonstrate damage and/or control methods.

IV. Suggested Teaching Materials

A. References for Lesson 7

1. Apple Spray Schedule, 1973.
2. Characteristics of Common Rodenticides, Leaflet 337.
3. Crops and Soils, March 1971, pp. 14-16.
4. Entomology Series E., E.9, E.42, E.59.
5. Facts About Rodent Control, State of Illinois, Department of Public Health.
6. Fruit Grower, Feb. 1966, pp. 18, 20-29.
7. Fundamentals of Insect Life, pp. 175-179.
8. Guide for Chemical Control of Vegetable Disease, 1973, PPA-2.
9. Plunder Underground, 1967.
10. Soybean Cyst Nematode, PPA-3, University of Kentucky.
11. Strawberry Insect and Disease Control, 1973.
12. Stone Fruit Spray Schedule, 1973.
13. Washington Pest Control Handbook.

B. Resource personnel

1. For specific personnel, see Vo Ag Directory

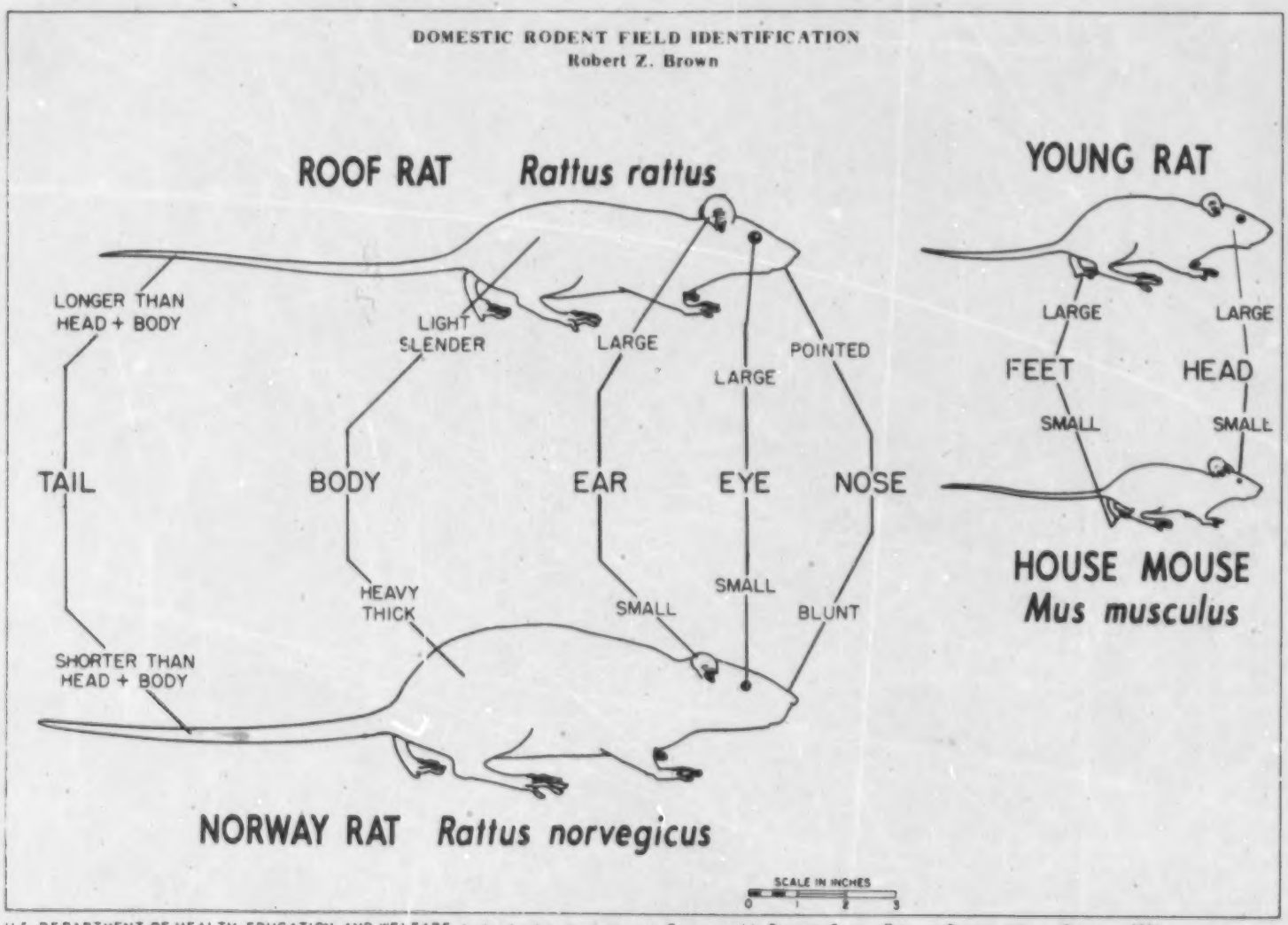
of Resource People in Kentucky.

C. Addio-visuals
   1. Masters
      -1 Domestic Rodent Field Identification
      -2 Rodents: Pictorial Key
      -3 Characteristics of Common Rodenticides
      -4 Morphology of the Mite
      -5 Pictorial Key to Some Common Pest Birds
      -6 Know Your Nematode Problem
      -7 Life Cycle of the Barley Root-Knot Nematode

No. 1044-34

DOMESTIC RODENT FIELD IDENTIFICATION

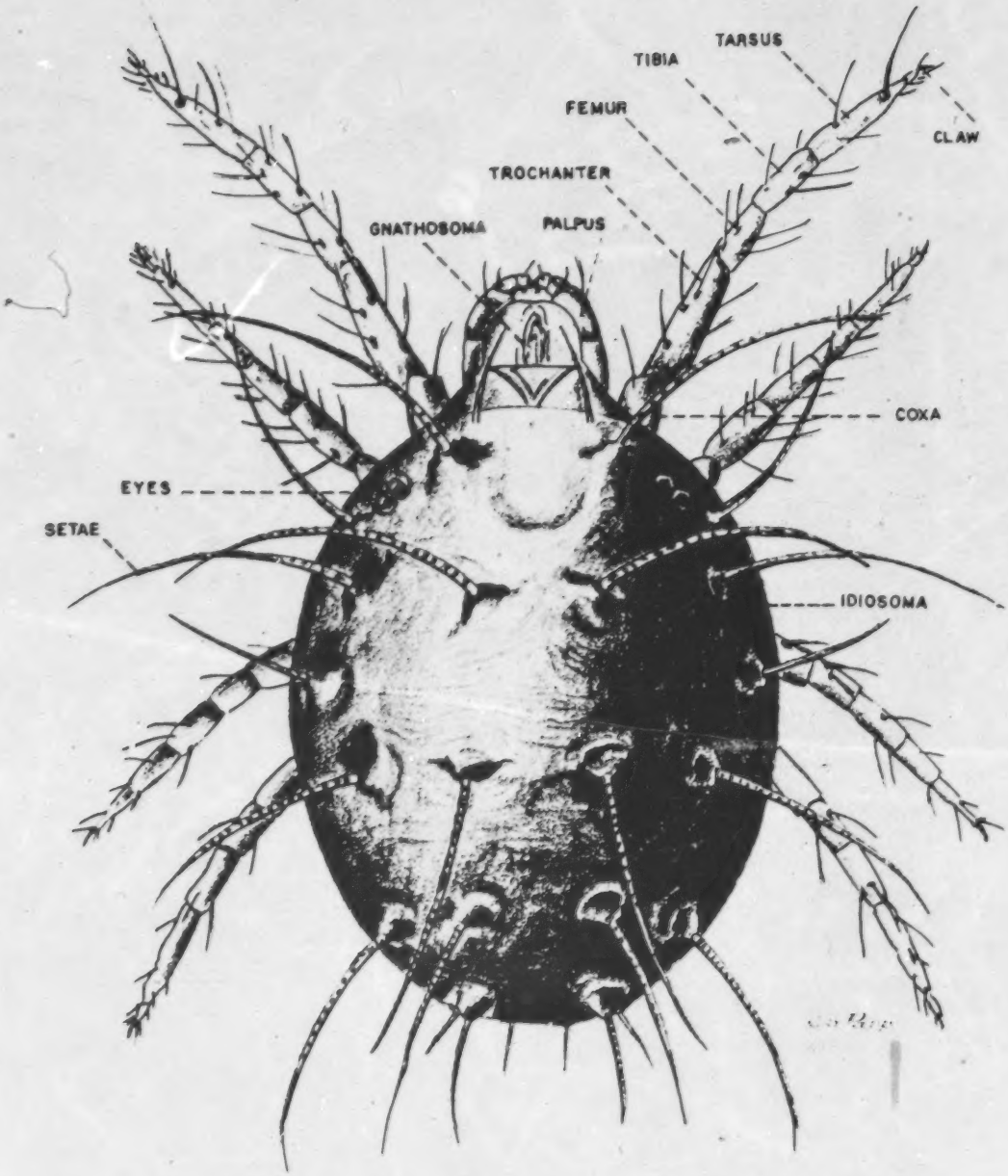
Robert Z. Brown



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE, Communicable Disease Center, Training Branch, Atlanta, Georgia - 1953

109-7-1

PAGES 145 & 146 OF THIS DOCUMENT WAS REMOVED PRIOR TO ITS BEING SUBMITTED TO THE ERIC DOCUMENT REPRODUCTION SERVICE BECAUSE IT WOULD NOT REPRODUCE IN MICROFICHE.



Greatly enlarged detailed drawing of citrus red mite.

SOURCE: American Fruit Grower. 109-7-4

WD.1098-38

PAGE 148 OF THIS DOCUMENT WAS REMOVED PRIOR TO ITS BEING SUBMITTED TO THE ERIC DOCUMENT REPRODUCTION SERVICE BECAUSE IT WOULD NOT REPRODUCE IN MICROFICHE.

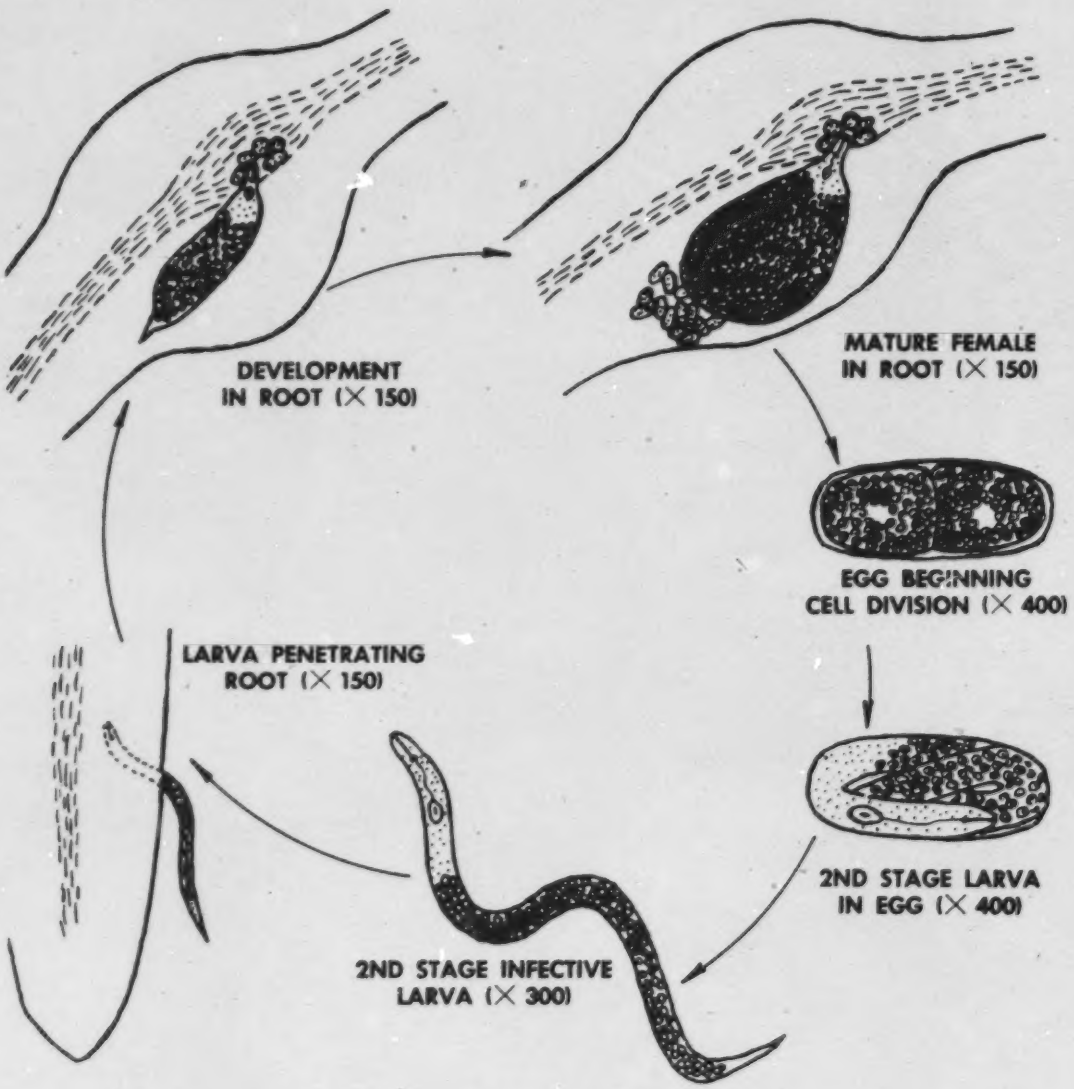
KNOW YOUR NEMATODE PROBLEM

What they're called	Host Crops
Cyst formers	
Cabbage Cyst Nematode, *Heterodera cruciferae*	Cabbage
Carrot Cyst Nematode, *H. carotae*	Carrots
Clover Cyst Nematode, *H. trifolii*	Clover and other legumes
Golden Nematode, *H. rostochiensis*	Irish potato, Tomato, Eggplant
Grass Cyst Nematode, *H. punctata*	Small grains, such as wheat
Hop Cyst Nematode, *H. humuli*	Hop, Hemp
Oat Cyst Nematode, *H. avenae*	Small grains, Corn, Grass
Pea Cyst Nematode, *H. goettingiana*	Peas
Soybean Cyst Nematode, *H. glycines*	Soybeans
Sugar Beet Nematode, *H. schachtii*	Celery, Sugar Beets, Cress, Turnips, Spinach, Radishes
Tobacco Cyst Nematode, *H. tabacum*	Tobacco, Tomato
Root penetrating nematodes (endoparasitic)	
Potato Rot Nematode, *Ditylenchus destructor*	Potato, Dandelion
Root-knot nematodes, Meloidogyne spp.	
(Several species and varieties)	Found in more than 1,700 host plants including small grains, grasses, fruits, vegetables, nursery crops and field crops.
Root lesion or meadow nematodes	
Smooth-headed nematode, *Pratylenchus brachyurus*	Potato, Corn, Peanuts, Cotton, Tobacco
Coffee Nematode, *P. coffeae*	Coffee, Tea, Abaca, Cane, Banana, Tobacco, Wheat, Corn, Olive, Apple, Nursery, and Floral Crops
Schribner's Meadow Nematode, *P. scribneri*	Potato, Strawberry
Thorne's Meadow Nematode, *P. thornei*	Wheat, Grains, Grass
Lesion Nematode, *Pratylenchus* sp.	Fruits, Citrus, Walnut, Grape, Raspberry, Rose
Corn Nematode, *P. Zeae*	Corn, Wheat
Rice Nematode, *Aphelenchoides oryzae*	Rice
Burrowing Nematodes *Radopholus similis*	Citrus, Ornamentals, Avocado
Kidney-shaped or Reniform Nematode, *Rotylenchulus reniformis*	Turf, Cotton, Peanut, Tomato, Ornamentals
Citrus Nematode, *Tylenchulus semi-penetrans*	Citrus trees, Olive
Nematodes that feed on root surfaces (ectoparasitic)	
Sting Nematode, *Belonolaimus* spp.	Corn, Cotton, Ornamentals, Celery, Vegetables, Peanut, Pine
Ring Nematode, *Criconemoides* spp. and *Criconema* spp.	Cotton, Peanut, Citrus, Deciduous Fruit
True Spiral Nematode, *Helicotylenchus* spp.	Peanut, Tobacco, Tomato, Clover
Lance Nematode, *Hoplolaimus* spp.	Nursery Crops, Cane, Alfalfa, Red Clover, Peppermint
Pin Nematodes, *Paratylenchus* spp.	Many Vegetable Crops
Spiral Nematodes, *Rotylenchus* spp.	Ornamentals
Stubby Root Nematodes, *Trichodorus* spp.	Corn, Celery, Beans, Peas, Tomato, Cotton, Beets, Peppers
Stylet Nematode, *Tylenchorhynchus* sp.	Tobacco, Corn, Cotton, Strawberry, Milo, Peanut, Beans, Ornamentals
Dagger Nematode, *Xiphinema* sp.	Cotton, Strawberry, Oats, Tobacco, Peaches, Nursery Stock

SOURCE: Plunder Underground, pp. 24, 25.

[redacted] 109-7-6

Life cycle of the barley root-knot nematode



SOURCE: Crops and Soils Magazine, March, 1971. 109-7-7

WD. 1048 - 39

APPENDIX

MY TEACHING PLAN FOR THIS COURSE

Why I am teaching this course (major learnings or outcomes expected)

ARRANGEMENTS FOR THE COURSE

Session No.	Date	Topic	Clock Hours

This page is for your convenience in planning and rearranging the content of this course to meet local needs and interests. Plan the course as it will be taught in the local school, showing the dates, class session number, topics, and the time in hours allocated to each topic.

TOPIC PLANNING FOR THIS COURSE

Name of Course _____

Name of Topic _____

Number of Class Meetings Allotted for this Topic _____

Teaching Objectives: (Learnings or outcomes for those enrolled)

Major Phases of the Topic: (Problems, jobs, areas, skills, key points, understandings, etc.)

Learning Activities: (Field trips, completing summary forms, panel discussions, demonstrations, etc.)

Teaching Materials Needed: (From resource material list or file)

RESOURCE MATERIALS FOR TEACHING

Unit _____ Lesson _____

Reference Books	Date Used	File Location
Other References: Bulletins, Magazines, Etc.		
Audio-Visuals: Slides, Filmstrips, Motion Pictures		
Magnetic, Flannel, and Bulletin Boards		
Charts, Maps, Posters		
Transparencies		
Specimens, Models, Mounts		
Human and Community Resources		

Please complete and return to:
Maynard J. Iverson
7 Dickey Hall
University of Kentucky
Lexington, Kentucky 40506

ADULT INSTRUCTIONAL UNIT EVALUATION

-- A Questionnaire for Kentucky VoAg Teachers of Adults

PART I -- GENERAL INFORMATION

How many years of teaching experience do you have? _____

How many years have you taught adults in agriculture? _____

How long has it been since you have taken your last college classwork in agriculture_____; in education _____; (undergraduate, graduate, or non-credit course)? _____

What is the highest degree you hold? _____

How many teachers are in your department?_____

What age level students do you teach? (✓one)
a) ____high school and adult b)_____adult only

How many other units from the University of Kentucky have you used in your teaching during the past few years?_____

PART II -- UNIT INFORMATION

NAME OF UNIT EVALUATED:_____

TYPE OF CLIENTELE TAUGHT: _____Adult Farmer ____Young Farmer
_____Other Adults (please specify)_____

Average number attending class _____

Was the interest level _____high? _____moderate? _____low?

How many lessons did you use?_____ How many class periods?_____

Indicate any lesson you added or deleted_____

_____

_____

_____

Directions: Place a check mark (✓) in the appropriate left hand column to rate the following components of the unit based on your own observations. A ranking of 5 represents an excellent rating decreasing to a rank of 1 for poor. For the open-ended questions please write on the back if additional space is needed.

Unit Design

5	4	3	2	1	
					General arrangement of parts
					Appropriateness of format for teaching adults
					Length of the unit
					Usefulness of suggestions for using the unit
					Number of lessons
					Order of lessons

Specific comments:_____

_____

PLEASE CONTINUE ON NEXT PAGE

Objectives in the Unit

5 4 3 2 1

_____ Clearly stated
_____ Reasonable to reach in the allotted time
_____ Relevant to needs of the adult learner
Specific comments: _____

_____

Technical Content

5 4 3 2 1

_____ Usefulness of introductory material
_____ Sufficiently detailed for direct use in class
_____ Related to objectives
_____ Divided into appropriate problem areas
_____ Up-to-date
_____ Accuracy
_____ Reasonably complete
Specific comments: _____

_____

Suggestions for Teaching the Lessons

5 4 3 2 1

_____ Appropriate information for the teacher to bring out
_____ Appropriate items to be secured from class members
_____ Suitable conclusions
_____ Suitability of enrichment activities
Specific comments: _____

_____

Resources and Teaching Aids in the Unit

5 4 3 2 1

_____ Up-to-date
_____ Accessibility to the teacher
_____ Relevance to the unit
_____ Adaptability to the teaching plan
Specific comments: _____

_____

With what parts of the unit do you feel you need additional help?

___ None of them
___ Objectives
___ Content
___ Course organization and planning
___ References
___ Resources and teaching materials
___ Teaching methods
___ Other (Specify) _____

PART III -- GENERAL REACTION

Please indicate any other strengths and weaknesses that you have observed in the unit and any suggestions for improvement, revision, and/or implementation (use the back of this sheet if needed).